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Developing Language Assessment Literacy of Pre-Service English Teachers: Frameworks and Cultivation Strategies

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Abstract: Assessment is a crucial aspect of the teaching process for teachers. Teachers' assessment literacy is closely related to students' learning outcomes. The language assessment literacy of foreign language teachers is a significant component of both teachers' professional development and students' learning, and it has become a research hotspot in the field of domestic language testing. Based on clarifying the theoretical framework of language assessment literacy, this paper proposes the main cultivation paths for pre-service English teachers' language assessment literacy, aiming to provide inspiration and references for the cultivation, reform, and development of teachers in basic foreign language education.

Keywords: Pre-service English teachers; Language assessment literacy; Cultivation strategies

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1. Introduction

In October 2020, the government of China officially released the *Overall Plan for Deepening Education Evaluation Reform in the New Era*, marking a milestone in the transformation of assessment as a critical aspect of school quality improvement. When teachers consider "assessment" as an indispensable part of "classroom teaching," students' meta-cognitive abilities, learning motivation, and classroom teaching effectiveness significantly improve^[1]. The assessment methods adopted by teachers determine the content and approach of their teaching and students' learning^[2]. Language assessment literacy has become a hot topic in the field of foreign language and language testing both domestically and internationally. However, the current situation of English teachers' assessment literacy is not optimistic: teachers often overlook understanding assessment standards and principles, lack knowledge and skills related to the development and use of assessment tools^[3,4], fail to accurately interpret and convey assessment results^[5,6], and have never or rarely received pre-service or formal assessment training^[7,8].

The new curriculum standards define classroom assessment as a core element of classroom teaching, explicitly stating that teachers should transition from being “consumers” to “producers” of student academic assessment results, assuming proper assessment powers and responsibilities. Improving teachers’ assessment literacy has become urgent and the importance of enhancing pre-service English teachers’ language assessment literacy is evident.

2. Conceptual connotation of language assessment literacy

2.1. Assessment literacy

Stiggins was the first to introduce the term “assessment literacy,” defining its connotation in terms of knowledge and skills. He believed that assessment literacy refers to the evaluator’s ability to identify the reliability of assessments, understand assessment content, methods, and issues, and know how to avoid problems in assessments^[1]. Since then, many researchers in the fields have defined the connotation of “assessment literacy,” but none have exceeded the scope initially framed by Stiggins, which focuses on the literacy required for student academic assessment^[9]. Gee and Willis *et al.* interpreted assessment literacy from a sociocultural perspective, viewing assessment as a dynamic, context-dependent social activity^[10,11]. Looney *et al.* injected social-emotional factors into assessment literacy, defining it as “teacher assessment identity”^[12].

Domestic researchers Gao and Sheng believed that the definition of assessment literacy should be considered from a multidimensional perspective. It refers to teachers’ abilities and qualities regarding correct assessment concepts, assessment knowledge and skills, and how to put assessment results into practice and implement assessment plans^[13]. Jiang believed that assessment literacy is the knowledge and skills that teachers should possess to evaluate language under the new evaluation paradigm. Some scholars have transcended the traditional views of personal knowledge, skills, and cognition, placing assessment literacy in dynamic practical contexts and conducting critical research on the practice and process of teachers’ assessment literacy^[14]. Zheng viewed assessment literacy as the key ability and ethical character for teachers to conduct reasonable academic evaluations of students under the concept of promoting learning^[15]. Wang believed that assessment literacy refers to the concepts, knowledge, skills, and related abilities that teachers should have in various fields of assessment activities^[16].

2.2. Language assessment literacy

Besides the assessment literacy defined by Stiggins and others, foreign language teachers also need assessment literacy with characteristics specific to the foreign language discipline. The concept of language assessment literacy originates from assessment literacy in the field of general education. Foreign scholars have conducted systematic research on foreign language teachers’ assessment literacy since the early 21st century.

Starting from the training of teachers’ assessment literacy, Brindley constructed a content framework for foreign language teachers’ assessment training, including five modules: social background, definition and description of abilities, compilation and evaluation of language tests, evaluation in foreign language courses, and evaluation practices. These modules directly point to the assessment literacy of foreign language teachers^[17]. Boyles believed that language teacher assessment literacy refers to the ability of language teachers to understand the principles and practices of language testing, analyze different evaluation methods and results, and use evaluation results to improve teaching^[5]. Based on his long-term experience in language testing

research and practice, Davies provided a concise and clear definition of language assessment literacy from three dimensions: principles, knowledge, and skills. “Principles” refer to the theoretical foundation and ethics that guide the development and use of examinations; “Knowledge” is the language ability and the knowledge system of educational measurement that supports examination practice; “Skills” represent practical abilities in test design, scoring, data analysis, and performance reporting^[18]. Postmodernists, represented by Inbar-Lourie, understand language assessment literacy from a social constructivist perspective, emphasizing the co-construction of knowledge and meaning in a social environment, thus forming a more comprehensive and dynamic view of language assessment literacy. Inbar-Lourie reviewed research literature on assessment literacy in the fields of education, language teaching, and testing, proposing that language assessment literacy consists of three core modules: “why to evaluate,” “what to evaluate,” and “how to evaluate”^[19]. Fulcher expanded the concept of assessment literacy based on empirical research. He systematically described the language assessment literacy system, believing that language assessment literacy refers to the ability of language teachers to design and develop language tests, be familiar with the language testing process, understand the concepts and principles of evaluation practices, and place knowledge, skills, processes, principles, and concepts within a broader historical, social, political, and philosophical framework^[20].

Peng defined language teacher assessment literacy as the degree of language teachers’ understanding of foreign language testing and their ability to proficiently master relevant knowledge of foreign language testing^[8]. Jin believed that language assessment literacy is a multidimensional and complex concept that should be approached from various levels such as evaluation environment, evaluation process, principles and concepts, as well as evaluation knowledge, skills, and abilities. These knowledge and skills should be learned to varying degrees according to the evaluation tasks^[21]. Lin provided a more detailed and specific definition of language assessment literacy. He pointed out that “language assessment literacy refers to teachers’ comprehensive and profound understanding of the language they teach and language learning, possessing basic knowledge, skills, and abilities to design, develop, or evaluate language classroom assessments. They are familiar with the language evaluation process, aware of the principles and concepts behind language evaluation practices, can actively involve learners in the language evaluation process, use appropriate feedback to effectively help learners set and achieve learning goals, and have a good understanding of the role and function of language evaluation in a specific teaching environment”^[22].

Language assessment literacy “is derived from the field of general education and possesses unique attributes of language disciplines, such as emphasizing teacher-student interaction, highlighting language and cultural communication, and focusing on humanistic development”^[23]. Gao and Sheng believed that language teacher assessment literacy actually refers to teachers’ ability to understand the principles of language testing and evaluation, design and develop language tests and classroom evaluation tools, be familiar with their operating principles and processes, master the codes of conduct for their implementation, and understand their social impact^[13].

3. Framework for evaluating language assessment literacy

3.1. Analysis of foreign language assessment framework construction

From the perspective of systems theory, Fulcher redefined the concept of language assessment literacy through an analysis of the needs of language teachers for test training via online closed-ended questionnaires and open-ended questions. This redefined concept not only includes knowledge, skills, and principles related

to assessment literacy but also covers the reasons and impacts of assessment practices from historical, social, political, and philosophical perspectives. Based on this, he constructed a three-dimensional language assessment literacy system, namely, practical abilities in language testing (knowledge, skills, and abilities to develop, implement, and use language assessments); guidelines for language assessment practices (evaluators need to be familiar with the assessment process, principles, and concepts); and environmental factors (evaluators need to conduct evaluations in the context of historical, social, political, and philosophical backgrounds) ^[20].

Based on a five-level classification of language assessment literacy, Taylor constructed an eight-dimensional model of language assessment literacy. This model distinguishes the language assessment needs among the various interest groups. The various interest groups have different needs for language assessment literacy and their levels of mastery of assessment knowledge also differ ^[24]. From the core to the intermediary and then to the peripheral, different interest groups should “find their seat” based on actual needs and identify the language assessment literacy that suits their specific context. For classroom teachers, language assessment literacy first requires a mastery of pedagogical knowledge, followed by evaluation techniques, local practices, personal beliefs and characteristics, socio-cultural values, and finally, evaluation of theoretical knowledge, scores and decision-making, principles, and concepts.

Through a review of the literature, Giraldo found that among the many interest groups in language assessment literacy, teachers are the core members of this group, but their assessment literacy is generally low ^[25]. He proposed the core components of teachers’ language assessment literacy: knowledge, skills, and principles. These three dimensions are ranked in order of importance, with each sub-dimension containing 66 descriptors. These descriptors are interdependent and mutually reinforcing, working together to form a cohesive framework. Language assessment literacy knowledge refers to relevant theories and concepts in applied linguistics, as well as contextual knowledge of language assessment. Skills include teaching skills, language assessment design skills, educational measurement skills, and technical skills. Principles involve awareness and action on key issues in language assessment.

3.2. Analysis of domestic foreign language assessment framework construction

The domestic scholar Lin’s model of language assessment literacy consists of three structural dimensions: principles, knowledge, and skills. These three dimensions collectively determine a teacher’s language assessment literacy. Among them, “under the guidance of principles, considering the sociocultural environment of teaching, and taking into account fairness and ethical issues, can we ensure the correct use of language assessment” ^[22]. “Knowledge” refers to the basic concepts of measurement, knowledge of the language system, and relevant applied linguistics that teachers should master. “Skills” include the process of teachers applying their understanding of language assessment knowledge under the guidance of principles to practical operations.

Gao and Sheng’s framework for language teacher assessment literacy comprises three dimensions: “assessment philosophy,” “assessment knowledge,” and “assessment skills.” The assessment philosophy of foreign language teachers consists of their understanding of assessment subjects, methods, principles, and other dimensions, which is represented through teachers’ discourse and behavior, reflecting their value orientation in assessment. Assessment should also be integrated with the teaching context and social emotions, reflecting the dynamism of the assessment literacy framework. Assessment philosophy includes assessment cognition, assessment attitude, assessment principles, and social emotions. Language assessment

knowledge covers assessment theory, assessment practice, and assessment environment knowledge. Language assessment skills should include selecting assessment methods, interpreting assessment results, and applying assessment results ^[13].

4. Cultivation strategies for pre-service English teachers' language assessment literacy

Research on teacher language assessment literacy in China mainly focuses on topics such as the construction of teacher assessment literacy frameworks, the overall level of assessment literacy among teachers in different regions, and language testing and assessment courses. However, there is a lack of research on methods for developing the language assessment literacy of pre-service English teachers. Due to the urgent need to enhance teachers' assessment literacy, it is clear that improving the language assessment literacy of pre-service English teachers is of significant importance.

This paper proposes specific strategies to develop the language assessment literacy of pre-service English teachers in China from several aspects. Firstly, it emphasizes the importance of investigation and research to understand the current status and needs of these teachers. Secondly, the author highlights the curriculum development to create a multi-level curriculum system. Lastly, it encourages pre-service teachers to design simple and practical language assessment systems or tools, leveraging advancements in technology to improve their assessment skills and better understand teaching and learning situations.

4.1. Emphasizing investigation and research to understand the current status and needs of pre-service English teachers' language assessment literacy

Currently, the level of language assessment literacy among pre-service English teachers in China is relatively low, making it urgent to understand their actual situation regarding assessment literacy. It is particularly crucial to ascertain the current status and needs of pre-service English teachers' language assessment literacy through questionnaires, interviews, and classroom observations. Questionnaires can provide a large sample of relatively authentic and comprehensive data on language teachers' assessment literacy, providing a basis for accurately developing plans to improve teachers' language assessment literacy. To gain a deeper understanding of the dynamic development of pre-service English teachers' language assessment literacy, one or several sub-dimensions from the assessment framework can be selected as research perspectives, integrating questionnaires, interviews, and classroom observations to conduct case studies on teachers' assessment literacy. This allows for longitudinal tracking of their development trajectories, paths, or change patterns ^[26].

4.2. Emphasizing curriculum development to create a multi-level curriculum system for pre-service English teachers' language assessment literacy

The insufficient and non-standardized professional courses focusing on "language assessment" are significant factors hindering the improvement of pre-service English teachers' language assessment literacy. Increasing the content and specificity of "language assessment" courses in the talent training programs for pre-service English teachers and normal university students is important to address the deficiency in their language assessment literacy.

Firstly, emphasis should be placed on theoretical teaching. Based on offering language assessment courses on campus, we should fully utilize online courses from platforms such as China's foreign language

MOOC platform and China MOOC to complement the inadequacies of professional courses on campus. This will effectively enhance and consolidate pre-service English teachers' assessment philosophy and knowledge.

Secondly, applied teaching should be strengthened by offering corresponding short-term courses and workshops. These courses and workshops should interpret the *China Standards of English Language Ability* and the *English Curriculum Standards for Compulsory Education (2022 Edition)*. By interpreting these scales and curriculum standards, theoretical learning can be applied to practical situations, training pre-service English teachers in various aspects of assessment literacy, including assessment philosophy, knowledge, and skills. It is also necessary to offer corresponding short-term courses and workshops to help pre-service English teachers understand the writing philosophy and framework of various English textbooks for basic education stages.

Finally, practical teaching should be reinforced. In micro-teaching practice courses, pre-service English teachers' language assessment skills should be strengthened through simulated classroom teaching. During "educational internships," pre-service English teachers can observe real classrooms to understand the application of language assessment skills both inside and outside the classroom by in-service teachers. In "educational seminars," instructors guide pre-service English teachers to experience real classrooms and further enhance the practice of language assessment skills in classroom teaching through methods such as teaching discussions, self-reflection, and peer support. During the "graduation internship" stage, pre-service English teachers gain a deeper understanding of specific teaching content and teaching evaluation processes through more in-depth and authentic school English teaching experiences and observations. They can practice language assessment philosophy, knowledge, and skills more broadly, gradually improving their language assessment literacy in this process.

4.3. Enhancing practical application to encourage pre-service English teachers to design simple and practical language assessment systems or tools

With the continuous advancement of computer technology and artificial intelligence, language assessment systems have become crucial tools for evaluation. The opening and application of "technology-enabled" language assessment systems have a significant impact on language learning for teenagers. Feedback from diagnostic assessment systems helps teachers and students understand teaching and learning situations, promotes student learning, and improves classroom teaching^[27]. Information and communication technology has had a positive impact on teachers in the process of planning, implementing, regulating, and reflecting on assessments.

Although pre-service English teachers have some exposure to language assessment courses, internships, and practical training, most of the focus is on introducing macro evaluation concepts and knowledge. There is little training on systematic and scientific classroom evaluation design and the development of assessment system tools. Pre-service English teachers have a significant lack of ability to design and select simple and easy-to-operate classroom assessment scales for different language skills (listening, speaking, reading, writing, translation). In the future, English language teacher training may focus on the "evaluation skills" module in the assessment literacy framework, and conduct training based on the development of assessment scales for different stages and language skills.

5. Conclusion

This article analyzed the basic concepts and theoretical frameworks of language assessment literacy,

reviewed the main content and directions of language assessment literacy research, and proposed reflections on the cultivation of language assessment literacy for pre-service English teachers. It aims to contribute to the improvement of language assessment literacy among pre-service English teachers in China.

Research on language assessment literacy for foreign language teachers at home and abroad is still emerging, and there is still considerable room for expansion in terms of breadth and depth. Inbar-Lourie pointed out in the editor's note of the *Language Testing* special issue that research and development tasks of language assessment literacy are arduous^[28].

Firstly, to develop the language assessment literacy of foreign language teachers, more related research is needed to build a theoretical system suitable for the development of language assessment literacy among Chinese foreign language teachers. Secondly, research on the interactive relationship between teachers' language assessment literacy and students' assessment literacy is needed. Both language teachers' and students' assessment literacy have attracted great attention in the academic community, but it is rare to reveal what kind of interactive relationship exists between the two, that is, to explore whether and how teachers' assessment literacy affects students' assessment literacy. Finally, it should be noted that this article only focuses on the group of pre-service English teachers, and the language assessment literacy of in-service English teachers and teachers of other languages is also worthy of further study.

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Exploring Competitive Strategies of Preschool Teacher Education Program Based on SWOT-QSPM: A Case Study of Zengcheng Vocational and Technical School in Guangzhou City

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Abstract: This paper employs the SWOT-QSPM (Strength, Weakness, Opportunity, Threat-Quantitative Strategic Planning Matrix) analytical framework to conduct a strategic study on the preschool teacher education program, taking the preschool teacher major of Zengcheng Vocational and Technical School in Guangzhou City as an example. Through in-depth interviews and qualitative and quantitative analysis methods, the current external opportunities and threats, internal strengths, and weaknesses faced by the major are assessed. Alternative strategies are proposed, and then the QSPM method is used to quantitatively evaluate these alternative strategies. It is concluded that a differentiation strategy should be adopted as the competitive strategy for the preschool teacher education program. The research findings have significant reference value for the development and planning of similar preschool teacher majors in higher vocational colleges. The practical significance lies in the fact that the research conclusions can be directly applied by education providers. The innovative significance lies in providing career planning references for current preschool teacher major students and their parents through strategic analysis.

Keywords: Higher vocational colleges; Preschool teacher education; Differentiation strategy; SWOT-QSPM

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1. Introduction

In the context of emerging new forms of productivity, the high-quality development of the early childhood education industry imposes increasingly stringent quality requirements on preschool teachers. Consequently, competition for the prospects of graduates from preschool education majors has intensified. Faced with fierce employment market competition and evolving industry demands, students majoring in preschool education at Zengcheng Vocational and Technical School need to formulate scientific and reasonable career development plans. This paper aims to provide strategic decision-making support for the discipline construction of the

preschool education major by employing the SWOT-QSPM (Strength, Weakness, Opportunity, Threat-Quantitative Strategic Planning Matrix) analysis framework, integrating the curriculum design of the major with the cultivation of students' individual strengths. This is to assist graduates of this major in better adapting to the employment market and achieving their personal career goals.

2. Review of relevant theories and related research

2.1. Theory of competitive strategy

Michael Porter established a research framework in his book *Competitive Strategy*, arguing that firms should determine their strategies based on external competitive dynamics, primarily encompassing overall cost leadership, differentiation strategy, and focus strategy^[1-3].

- (1) Cost leadership strategy: The cost leadership strategy emphasizes gaining a competitive advantage by providing low-priced products or services through cost reduction, characterized by efficient production, strict control, and continuous innovation. Its implementation requires consideration of risks such as market demand and competitor counterattacks.
- (2) Differentiation strategy theory: The differentiation strategy leverages unique advantages to differentiate positioning from competitors in terms of products, brands, services, channels, creating sustained competitive advantages, enhancing customer recognition and loyalty, and promoting sales and profit growth. This includes differentiation in products, brands, services, channels, costs, image, personnel, etc.
- (3) Focus strategy theory: The focus strategy involves a series of actions to produce products or provide services to meet the needs of specific competitive market segments. It is characterized by a clear target market, concentrated resources, specialized services, and the establishment of barriers. The key elements of implementing a focus strategy are market segmentation, product or service specialization, resource optimization, and concentrating resources on selected target markets to achieve efficient operation and management.

2.2. Foundation of related research

In 2012, He proposed an application model for blended learning in the professional teaching system of vocational education based on the theory of blended learning^[4], providing a solution for the strategic implementation of preschool education programs. In the practice of the blended learning model, He conducted educational experiments using Java programming as an example and verified the correctness of the proposed model, offering a case solution for the strategic implementation of preschool education majors^[5]. Kong and Zhang pointed out that the main misconception in current preschool teacher education in China is the blurred positioning of educational goals and designed a “trinity” talent training model and construction strategy for higher vocational preschool education^[6]. Zhang proposed that the professional growth of novice kindergarten teachers should follow specific principles based on Vygotsky's zone of proximal development theory, and corresponding measures should be taken, including providing professional support, assigning professional mentors, and establishing growth platforms^[7]. He proposed a large-scale data clustering processing method, providing a rapid computer processing approach for data handling before decision-making at the business level strategy^[8]. Yang, after surveying male undergraduate students in preschool education, proposed multiple measures to improve their professional identity and employment rate, aiming to optimize the teacher structure in kindergartens^[9]. Sun reviewed rural preschool education, summarizing

the seven stages of development of rural preschool education policies in China under the leadership of the Communist Party of China over the past century, and proposed that the future trend of preschool education should focus on supporting rural early childhood care, urban-rural preschool teacher team building, and quality supervision ^[10]. He systematically proposed a strategic research model based on competitive strategy theory for the first time, using Company V as an example to formulate a competitive strategy for professional art education business, creating an integrated solution from strategic positioning to strategic implementation for the art education business ^[11].

These related studies, directly or indirectly, provide an academic foundation and perspective for the in-depth research of this paper.

3. External environment analysis

3.1. Macro-environment analysis

In the context of the macro-environment, education is influenced by economic cycles and national policy orientation. Here, a PEST analysis is employed.

- (1) Political: The country has increasingly emphasized the importance of early childhood education, issuing a series of policies and regulations to support its development, such as the “Opinions on Deepening Educational and Teaching Reforms to Comprehensively Improve the Quality of Compulsory Education,” providing policy guarantees for the preschool teacher profession. The education sector has continuously raised the requirements for preschool teachers’ qualification certification and continuing education, promoting the standardized and professional development of the industry.
- (2) Economic: According to the latest data from the National Bureau of Statistics, the market size of the early childhood education industry continues to expand, with families increasing their investment in early childhood education. As residents’ income levels rise, the early childhood education market is expected to maintain stable growth in the future.
- (3) Sociocultural: Society’s expectations for the quality of early childhood education have increased, raising the requirements for preschool teachers’ professional competence and comprehensive abilities. Families have a growing demand for personalized early childhood education services, leading to an increased demand for preschool teachers with special skills, such as those proficient in music, dance, and art.
- (4) Technological: The rapid development of educational technology, including online and intelligent education, has provided new teaching models and tools for early childhood education. The continuous updating of early childhood education software and teaching tools requires preschool teachers to continuously learn and adapt to new technologies, improving teaching efficiency and quality.

3.2. Industry environment analysis

The early childhood education industry is experiencing rapid development, with the country increasing its emphasis and investment in this field. As society’s expectations for the quality of early childhood education rise, so do the requirements for preschool teachers’ professional competence and comprehensive abilities. The early childhood education industry is gradually moving towards diversification and specialization, with an increased demand for preschool teachers with individual expertise.

In terms of employment market demand, competition in the job market for preschool education majors is intense, but those with unique individual expertise and higher overall quality are more popular. When recruiting, kindergartens not only focus on preschool teachers' basic professional competence but also increasingly value their special skills in art, science and technology, sports, etc. With the emphasis on family education, the demand for preschool teachers who can provide personalized family education guidance is also increasing.

3.3. Competitor analysis

Although vocational colleges compete directly for students, education, at the national level, does not involve the cutthroat red ocean competition seen in corporate warfare. Therefore, this section's analysis of competitors is omitted in this context. However, for school administrators or individual students, to provide more practical guidance for personal employment and help schools develop their unique characteristics, this section's analysis can be added independently to obtain a more accurate strategic positioning and make precise tactical responses.

3.4. External factor evaluation matrix

Based on the qualitative analysis presented in sections 3.1. and 3.2., further segmentation, and data analysis, the external factor evaluation (EFE) matrix can be derived, as shown in **Table 1**.

Table 1. EFE analysis table for preschool teacher education business

Key factors	Weight	Rating (1–4)	Weighted score
External opportunities			
O1: Stable growth of preschool education market over five years	0.15	4	0.6
O2: Enhanced government support for preschool education policies	0.15	4	0.6
O3: Increasing household investment in preschool education	0.1	4	0.4
O4: Rising demand for personalized preschool education services	0.1	4	0.4
O5: Rapid development of educational technology	0.1	3	0.3
Subtotal for opportunity factors			2.3
External threats			
T1: Intense competition in the preschool teacher industry	0.1	2	0.2
T2: Heightened requirements for preschool teacher qualifications and continuing education	0.1	2	0.2
T3: Increased economic uncertainty	0.05	2	0.1
T4: Risk of policy changes in education	0.05	2	0.1
T5: Elevated societal expectations on preschool teachers	0.1	3	0.3
Subtotal for threat factors			0.9
Total score	1		3.2

4. Internal environment analysis

4.1. Tangible resources

- (1) Teaching facilities: The school boasts modern teaching buildings, laboratories, libraries, etc., providing excellent conditions for students' learning and living.
- (2) Practical training bases: The school has established partnerships with multiple kindergartens, offering students ample internship opportunities. Both the quantity and quality of these practical training bases are among the best in the region.
- (3) Current student body: The school has a stable enrollment of preschool education majors, with students of high caliber who have a keen interest in early childhood education. The quality of the student body is recognized by society.

4.2. Intangible resources

- (1) In terms of faculty strength, the school possesses a highly professional and experienced teaching staff capable of providing high-quality instruction and guidance to students.
- (2) Regarding the school's reputation, it enjoys a high standing in the local area, with a high employment rate for graduates and widespread recognition from employers.
- (3) In terms of campus culture, the school emphasizes the cultivation of professional qualities such as responsibility, compassion, and patience, fostering a positive campus culture that contributes to the comprehensive development of students.

4.3. Internal factor evaluation matrix

Based on the qualitative analysis of the internal environment outlined above, a condensed data analysis was conducted, resulting in the internal factor evaluation (IFE) matrix presented in **Table 2**.

Table 2. IFE analysis of career development in preschool education majors

Key factors	Weight	Rating (1-4)	Weighted score
Internal strengths			
S1: Well-equipped teaching facilities	0.1	4	0.4
S2: Leading number and quality of practical training bases	0.15	4	0.6
S3: High and stable quality of student enrollment	0.1	4	0.4
S4: Strong faculty strength	0.2	4	0.8
S5: Good reputation of the school	0.15	4	0.6
Subtotal			2.8
Internal weaknesses			
W1: Campus culture needs further enrichment	0.05	3	0.15
W2: Students' international perspective needs broadening	0.05	3	0.15
W3: Comprehensive quality of some students needs further improvement	0.05	3	0.15
W4: Educational technology application skills need strengthening	0.05	3	0.15
W5: Proportion of talented students needs increasing	0.1	3	0.3
Subtotal			0.9
Total score	1		3.7

5. Analysis of SWOT matrix

5.1. SWOT matrix

Based on the data from the EFE and IFE analyses, a SWOT alternative strategy matrix can be formulated, as presented in **Table 3**.

Table 3. SWOT matrix for early childhood education major's educational business internal conditions

Internal conditions External environment	Strengths (S)	Weaknesses (W)
	S1: Well-equipped teaching facilities S2: Leading number and quality of practical training bases S3: High and stable quality of student enrollment S4: Strong faculty strength S5: Good reputation of the school	W1: Campus culture needs further enrichment W2: Students' international perspective needs broadening W3: Comprehensive quality of some students needs further improvement W4: Educational technology application skills need strengthening W5: Proportion of talented students needs increasing
Opportunities (O)	SO strategy	WO strategy
O1: Stable growth of preschool education market over five years O2: Enhanced government support for preschool education policies O3: Increasing household investment in preschool education O4: Rising demand for personalized preschool education services O5: Rapid development of educational technology	SO1: Leveraging well-equipped teaching facilities to expand enrollment and provide high-quality educational services. SO2: Enhancing the utilization of practical training bases to develop personalized practical courses that meet market demands. SO3: Relying on high-quality student intake to offer premium educational services and elevate the school's brand. SO4: Strengthening teacher training to improve teaching quality and lead educational innovation. SO5: Capitalizing on a good reputation to enhance brand promotion and expand market share. SO6: Utilizing policy support to apply for project funding and enhance the school's overall strength. SO7: Providing more personalized services to satisfy families' demand for high-quality education. SO8: Employing educational technology to improve teaching efficiency and quality, leading the way in educational innovation.	WO1: Enriching campus cultural activities to enhance the school's appeal. WO2: Strengthening international exchange and cooperation to broaden students' international perspectives. WO3: Enhancing comprehensive quality education to improve students' overall development capabilities. WO4: Intensifying training in educational technology application to elevate teaching standards. WO5: Strengthening the cultivation of talented students to enrich the school's distinctive characteristics.
Threat (T)	ST strategy	WT strategy
T1: Intense competition in the preschool teacher industry T2: Heightened requirements for preschool teacher qualifications and continuing education T3: Increased economic uncertainty T4: Risk of policy changes in education T5: Elevated societal expectations on preschool teachers	ST1: Strengthen the maintenance and updating of teaching facilities to maintain competitive advantages and address industry challenges. ST2: Demonstrate the school's strengths through practical training bases, enhancing trust with partners and parents. ST3: Leverage the advantage of faculty resources to meet qualification certification and continuing education requirements. ST4: Strengthen faculty development to improve teaching quality and sustain competitive advantages. ST5: Enhance faculty training to ensure teachers meet qualification certification standards. ST6: Strengthen communication with government to stay informed about policy updates and adjust school strategies accordingly.	WT1: Enhance resistance to external threats by showcasing the achievements of high-quality students. WT2: Bolster social trust through a good reputation, alleviating societal pressure on early childhood educators' expectations. WT3: Enhance students' employment competitiveness by improving their comprehensive qualities, thereby countering external threats. WT5: Strengthen financial management to reduce economic risks.

5.2. SWOT quadrilateral strategic focus analysis

The SWOT quadrilateral analysis is a method that visually presents the four dimensions of strengths, weaknesses, opportunities, and threats, aiding researchers in clearly seeing the possible paths for business development. In this quadrilateral image, each vertex represents one aspect of the SWOT analysis—strengths, weaknesses, opportunities, and threats, while the lines connecting these vertices reveal their interrelationships and influences. Through this intuitive graphical representation, it is possible to comprehensively examine the strategic environment in which the art education business operates, providing strong support for formulating targeted development strategies.

Based on the external opportunity score of $O = 2.3$ and external threat score of $T = 0.9$ derived from the EFE matrix, as well as the internal strength score of $S = 2.8$ and internal weakness score of $W = 0.9$ from the IFE matrix, a data image analysis was conducted using the SWOT quadrilateral. The combined effect of key factors in the external and internal environments is represented by the center of gravity, with the coordinates of the center of gravity calculated using Formula 1. **Figure 1** shows that the education business of the preschool education major currently lies in the SO quadrant, indicating that the strategic decision is an SO growth strategy.

$$P(x,y) = \left(\frac{\sum x_i}{4}, \frac{\sum y_i}{4} \right) \quad (\text{Formula 1})$$

Calculation: $P(x,y) = [(2.3-0.9+0+0)/4, (2.8-0.9+0+0)/4] = (0.35, 0.475)$

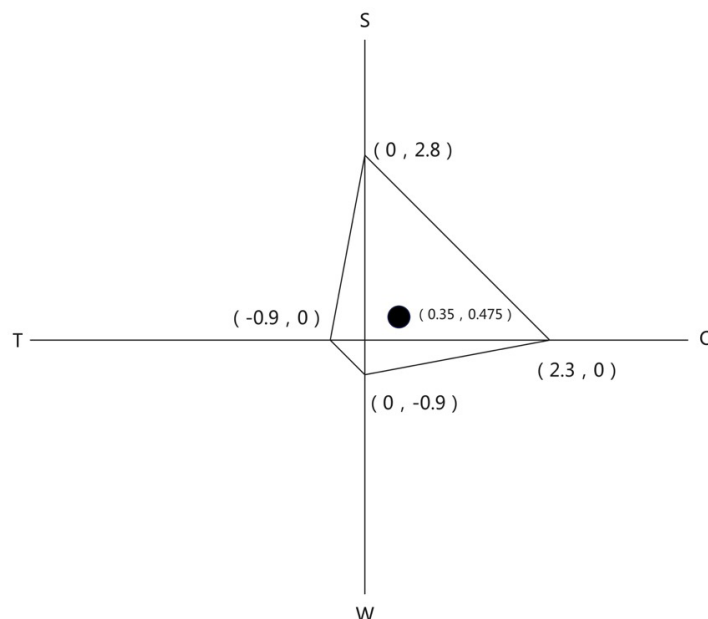


Figure 1. SWOT quadrilateral strategic focus chart for the preschool education major

5.3. Alternative strategies

From **Table 3**, 24 alternative strategies are identified. Based on competitive strategy theory, these 24 alternative strategies are further categorized into three types: overall cost leadership strategy, differentiation strategy, and focus strategy, as presented in **Table 4**.

Table 4. Alternative competitive strategies for the education business of the preschool education major

Types	Alternative strategies
Cost leadership strategy	ST1, WT5
Differentiation strategy	SO1, SO2, SO3, SO4, SO5, SO7, SO8, WO1, WO2, WO3, ST2 ST3, ST4, WT1, WT2, WT3
Focus strategy	SO6

6. QSPM

The QSPM (Quantitative Strategic Planning Matrix) is a tool utilized for evaluating and selecting strategies. It integrates external opportunities and threats, internal strengths and weaknesses, and assigns scores based on the attractiveness of strategies towards key success factors, leading to the development of **Table 5**.

Table 5. QSPM matrix for the competitive strategies of preschool teacher education business

Project	Key factors	Weight	Cost leadership strategy		Differentiation strategy		Focus strategy	
			AS	TAS	AS	TAS	AS	TAS
Opportunities	O1: Stable growth of preschool education market over five years	0.15	2	0.3	4	0.6	3	0.45
	O2: Enhanced government support for preschool education policies	0.15	2	0.3	4	0.6	3	0.45
	O3: Increasing household investment in preschool education	0.1	4	0.4	4	0.4	3	0.3
	O4: Rising demand for personalized preschool education services	0.1	4	0.4	4	0.4	4	0.4
	O5: Rapid development of educational technology	0.1	4	0.4	4	0.4	4	0.4
Threat	T1: Intense competition in the preschool teacher industry	0.1	2	0.2	3	0.3	3	0.3
	T2: Heightened requirements for preschool teacher qualifications and continuing education	0.1	3	0.3	4	0.4	3	0.3
	T3: Increased economic uncertainty	0.05	2	0.1	4	0.2	2	0.1
	T4: Risk of policy changes in education	0.05	3	0.15	4	0.2	3	0.15
	T5: Elevated societal expectations on preschool teachers	0.1	3	0.3	4	0.4	2	0.2
Strengths	S1: Well-equipped teaching facilities	0.1	4	0.4	4	0.4	3	0.3
	S2: Leading number and quality of practical training bases	0.15	4	0.6	4	0.6	3	0.45
	S3: High and stable quality of student enrollment	0.1	4	0.4	4	0.4	4	0.4
	S4: Strong faculty strength	0.2	4	0.8	4	0.8	4	0.8
	S5: Good reputation of the school	0.15	2	0.3	4	0.6	4	0.6
Weaknesses	W1: Campus culture needs further enrichment	0.05	3	0.15	4	0.2	3	0.15
	W2: Students' international perspective needs broadening	0.05	3	0.15	4	0.2	3	0.15
	W3: Comprehensive quality of some students needs further improvement	0.05	4	0.2	4	0.2	3	0.15
	W4: Educational technology application skills need strengthening	0.05	4	0.2	2	0.1	4	0.2
	W5: Proportion of talented students needs increasing	0.1	3	0.3	3	0.3	2	0.2
Total score		2	6.35		7.7		6.45	

The differentiation strategy scored 7.7, the highest among all, therefore, the competitive strategy for the preschool teacher education business should be the differentiation strategy.

7. Strategy implementation and decoding

The preschool teacher education business should adopt an SO growth-oriented differentiation strategy. Specific measures are as follows:

- (1) Service differentiation: Utilizing improved teaching facilities to expand enrollment scale, providing high-quality educational services, and meeting families' demand for high-quality education. Personalized services serve as a point of differentiation.
- (2) Curriculum differentiation: Enhancing the utilization of practical training bases, developing personalized practical courses to meet market demands, and introducing personalized courses as a means of differentiation.
- (3) Brand differentiation: Providing high-end educational services to enhance the school's brand.
- (4) Educational technology innovation differentiation: Leveraging educational technology to improve teaching efficiency and quality, leading educational innovation, strengthening teacher training, enhancing teaching quality, and guiding educational innovation.

8. Conclusion

This paper conducted a strategic study on the education business of the preschool teacher major at Zengcheng Vocational and Technical School through the SWOT-QSPM analysis framework. The study indicates that the preschool teacher major is currently in a growth phase and is suitable for adopting a differentiation strategy. The specific implementation of this strategy can be achieved through improving teaching quality, providing personalized courses and services, strengthening brand building, emphasizing educational technology innovation, and enhancing career planning education, among other efforts, to enhance students' comprehensive quality and professional competitiveness. In the future, the school should continue to deepen cooperation with kindergartens, expand practical channels, and timely update the strategic decision-making model based on industry changes, providing more scientific and reasonable career development planning guidance for preschool teacher major students.

Disclosure statement

The author declares no conflict of interest.

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Research on the Project-Based Teaching Model for Engineering Majors in Colleges and Universities

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Abstract: Based on the study of the Mechanical Design and Automation major and its relevance to teaching reform in higher education engineering programs, a project-based teaching model was introduced. This approach integrates teaching design, scheme argumentation, and the implementation of teaching activities with the project serving as the central framework. Course knowledge points are derived from the project topics, forming the foundation for a structured knowledge framework. The course content is modularized in alignment with the project design, enabling students to engage with professional courses on a module-by-module basis, guided by the project. Each course utilizes the project topic as a practical case, facilitating project-led teaching. A teaching system tailored to the research project is proposed, establishing a professional course structure closely linked to the project objectives.

Keywords: Teaching model; Project-based teaching; Engineering majors; Teaching system

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1. Introduction

With the rapid development of science and technology and the continuous upgrading of the industrial structure, society has put forward higher requirements for the quality and ability of engineering majors in colleges and universities. The traditional teaching mode mainly based on theoretical lectures has been difficult to meet the educational needs of cultivating innovative and practical engineering talents. In this context, the project-based teaching model emerged as a novel approach and shows unique advantages in the teaching of engineering majors in colleges and universities. This teaching model emphasizes taking the project as the core, closely integrating knowledge learning with practical operations, allowing students to master professional knowledge and skills in the process of completing the project, and cultivating engineering practical skills, innovative ability, and teamwork spirit. In-depth research on the project-based teaching model in engineering majors in colleges and universities is of great significance for improving the quality of engineering talent cultivation and promoting the reform of engineering education.

In recent years, in the field of educational model research, project-based teaching research has received extensive attention. In 2021, the Process Equipment and Control Engineering major at East China University

of Science and Technology proposed a “one-core, two-wings, two-wheel-driven” practical teaching model. This model takes double-creation (innovation and entrepreneurship) as the main body. Through the overall planning of the Academic Affairs Office and the in-depth development of each college, a high-quality science and technology innovation platform integrating “teaching, scientific research, and innovation practice” is created. At the same time, a two-wheel-driven curriculum system of “theoretical teaching” and “double-creation practice” with cross-spiral promotion is designed to realize the organic combination of “learning and doing” and improve students’ comprehensive quality and engineering practice level ^[1]. In 2024, the experience and effectiveness of the “scenario-project-based” teaching reform at Chongqing Jiaotong University involves leveraging “small” teaching reforms to solve the “big” problem of talent cultivation. While the “scenario-project-based” teaching breaks the boundaries of disciplines, courses, and resources, it strengthens the integrity, systematicity, and gradation design among disciplines, and promotes the transformation of teaching from the imparting of basic knowledge to the development of core literacy.

In teaching practice, according to the needs of different development stages and the differences among disciplines, the project-based teaching model should be continuously innovated and deepened to build efficient classroom teaching.

2. Analysis of the project-based teaching model

The project-based teaching model is a teaching method that takes actual projects as the carrier and organically integrates the teaching content of the course with project practice. In this model, teachers organize teaching activities around one or more specific projects. Students acquire knowledge and skills and cultivate the ability to solve practical problems by participating in the analysis, design, implementation, and evaluation of the project. Projects can be actual engineering tasks from enterprises, teachers’ scientific research projects, or simulated projects designed according to teaching goals ^[2].

The project-based teaching has changed the previous pure classroom theoretical teaching model. It extends to the application of theoretical knowledge and can better understand and consolidate the knowledge points of the course. The implementation of project-based teaching not only reconstructs the teaching content of the course, it breaks the boundaries of textbooks and courses, builds a knowledge system around specific engineering projects, and is a remodeling and integration of teaching content. Moreover, it also changes the mode of teaching and learning. After receiving the project learning tasks, students study the corresponding knowledge points with problems. Every explanation of the knowledge point is carried out around the task, with clear learning purposes and strong initiative.

The project-based teaching is conducive to improving students’ initiative and participation in learning, changing passive acceptance to active exploration. Project-based teaching emphasizes the practicality and application of teaching, allowing students to effectively combine theoretical knowledge with practical applications in the daily learning process. This teaching and training method can better meet the needs of social enterprises for professional talents.

3. Design of project-based teaching mode for engineering majors in colleges and universities

3.1. Scheme of professional course teaching system

Taking the teaching model of engineering major courses in colleges and universities as the research object,

according to the actual work processes in enterprises, the professional courses are divided into three levels: design-oriented professional courses, production-manufacturing-oriented professional courses, and test-verification-oriented professional courses. Taking the actual engineering design projects as the main line, teaching design, design scheme demonstration, and teaching organization and implementation are carried out, and systematic application analysis of teaching methods is performed. This model builds course knowledge points centered on project tasks, reconstructs the course teaching system, innovates the teaching mode, stimulates students' learning of professional courses in the form of project topic research, and focuses on cultivating students' knowledge application ability and the ability to solve actual engineering problems.

3.2. Implementation methods

The model research is based on the mechanical design and automation major in engineering. Teachers determine the overall goals of the project according to the course syllabus and professional training objectives, combined with the actual needs of enterprises or cutting-edge issues in the discipline.

The project is decomposed into several specific sub-tasks according to functional modules or work processes. Reasonable time nodes are arranged for each sub-task, and a project-module-based learning plan is formulated. Project-based teaching runs through all levels of professional course teaching and differentiated project-based teaching schemes are adopted at different course levels. The project-based teaching model introduces actual project topics before the study of professional courses, and at the same time combs and summarizes the knowledge points of each professional course used in each project topic, so that each student can clearly know the course knowledge points that the project topic will apply when learning each professional course. In the early stage of project implementation, teachers systematically explain the relevant theoretical basic knowledge according to the knowledge field involved in the project. During the explanation process, attention is paid to the connection between the theory and the project. Through case analysis, introduction of actual problems, and other methods, students are helped to understand the application scenarios of knowledge. Teachers guide students to conduct preliminary analysis and thinking of the project, put forward some enlightening questions, and help students clarify the entry point and solution ideas of the project, encouraging students to independently explore the knowledge and technology related to the project and cultivating students' innovative thinking.

3.3. Case analysis of the teaching model

The teaching model research has conducted a demonstration study by taking the "Automatic Loading and Unloading Function Transformation Project of CNC Lathe" as the supporting case of project-based teaching. The research content of the transformation project mainly includes three aspects: the automatic feeding system, the automatic loading and unloading system, and the control system. For example, the design of the automatic feeding device involves the design of mechanisms such as the planar four-bar mechanism, the cam mechanism, and the gear mechanism in the "Mechanical Principles" course that can achieve step feeding, and the design of the belt drive device and the power device such as the motor in the "Mechanical Design" course; the design of the automatic loading and unloading device involves the design of the rack and pinion mechanism, the kinematics and dynamics design of the mechanism, the design of the connecting rod mechanism in the "Mechanical Principles" and "Mechanical Design" courses, and the knowledge points such as the cylinder design and application in the "Hydraulic and Pneumatic Transmission" course; the matching design of the control system involves the application of servo motors, the motion control programming of

PLC, the drawing of electrical circuit diagrams in the “Electrical Control and PLC” course, the application of sensors and the machine tool circuit in the “Machine Tool Electrical Control” course, and the numerical control processing programming in the “Numerical Control Programming and Processing” course. The teaching of each course is based on these project-related knowledge points for the teaching design of each course, and finally a set of project-based professional course teaching system design plans is formed based on the mechanical design and automation major ^[3].

Similarly, when organizing the teaching content of the “Mechanical Design” course, the teacher takes the “Reducer Design” as the task and teaches in accordance with the idea of project design. Each teaching content completes certain tasks in the project, allowing students to learn the corresponding knowledge points as the project progresses. In the classroom, the teacher organizes the class through project inspiration, student interaction, knowledge reserve, and task completion. While completing the learning task of the “Mechanical Design” course knowledge, the task of the “Mechanical Design Course Design” is also completed. The integration of theory with practical application enhances the learning experience by making the purpose more focused, enriching the classroom environment, and increasing student engagement. Simultaneously, aligning with the development of the social industry, the introduction of reducer design in the context of new energy vehicle electric drive axles provides students with real-world application scenarios. This approach broadens their knowledge base, improves design capabilities and practical skills, and fosters the development of engineering design concepts and innovative thinking through hands-on experience in real-world projects ^[4].

4. Innovative effects of project-based teaching model

4.1. Innovation of teaching method

The project-based teaching model adopts a hybrid teaching method combining online and offline in the actual teaching process. There are rich teaching resources for online teaching on the Internet. We can fully utilize the high-quality online resources provided by various platforms, such as texts, pictures, videos, etc., to conveniently enrich teaching content and improve teaching quality. During the teaching process, corresponding videos can be played directly by linking to the network through the smart classroom; self-built courses are used to assist teaching, and learning tasks, homework tests, achievement displays, and sharing are set in advance. The construction of online courses has greatly enriched the teaching content of the courses, providing students with a more flexible and personalized learning method. Students can use their spare time to independently choose the learning progress and depth according to their own learning rhythm and comprehension.

4.2. Innovation in curriculum modular teaching design

The project-based teaching model decomposes the knowledge points according to the project design tasks, builds the framework of the curriculum knowledge structure, divides the curriculum knowledge into modules based on the project design, and thus conducts the curriculum teaching design, allowing students to carry out professional course learning by project and module. The modular teaching design of the curriculum is conducive to connecting all knowledge points and focuses on the practicality and systematic application of knowledge.

4.3. Innovation in the school-enterprise cooperation teaching system

In order to enhance students' learning interest, enrich classroom teaching content, and ensure high-quality

teaching, project-based teaching has effectively promoted cooperation between schools and enterprises. Both sides jointly develop projects, produce videos, etc., providing sufficient and high-quality resources for teaching activities. This closely connects the teaching content of the school with the industry demands and enables students to more intuitively apply the learned knowledge in actual working scenarios. The project-based teaching has greatly improved the teaching quality and effect, creating extremely favorable conditions for cultivating high-quality talents that meet the needs of society and enterprises.

5. Conclusion

The project-based teaching model connects the knowledge points of the courses centered on the projects, reconstructs the teaching system of the courses, promotes the optimization of the engineering professional course system, and effectively promotes the integration and expansion of teaching resources. The joint development of schools and enterprises has become an important way to expand resources. Enterprises provide schools with real project cases, advanced equipment, and technical support. Schools, on the other hand, align educational tasks with demand goals according to the needs of enterprises and cultivate tailor-made talents for enterprises. At the same time, resources such as laboratories and practical bases on campus are more fully utilized in project-based teaching, and it prompts schools to develop more project-related teaching materials^[5,6].

The project-based teaching model has significantly improved students' mastery of engineering professional knowledge, effectively stimulated students' innovative thinking and practical ability, greatly enhanced students' learning interest and enthusiasm, and cultivated students' ability to apply knowledge and solve practical problems. Thus, it is conducive to comprehensively improving students' comprehensive quality and enhancing their employment competitiveness.

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Research on Development Strategies for “Double First-Class” Construction of Subject Service in University Libraries

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Abstract: This paper aims to explore the development strategies for subject services in university libraries within the context of the “double first-class” initiative. By examining the relationship between “double first-class” construction and university library subject services, the study analyzes the current state of subject services, including resource development, service models, and team building. Drawing on domestic and international case studies, the paper proposes a series of targeted and practical strategies to enhance the quality of subject services in university libraries, thereby providing robust support for the advancement of the “double first-class” initiative.

Keywords: “Double first-class” construction; University library; Subject service; Development strategy

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1. Introduction

1.1. Research background and significance

The “double first-class” initiative aims to build world-class universities and first-class disciplines, representing a major strategic decision in China’s higher education sector. This initiative is of profound importance for enhancing the overall strength of China’s higher education system, cultivating high-quality innovative talents, and driving advancements in scientific and technological innovation as well as socio-economic development. University libraries play a crucial role as institutions providing essential services for teaching, scientific research, and discipline construction. Within the framework of “double first-class” construction, these libraries undertake key responsibilities, including offering extensive subject resources, delivering efficient subject-specific services, and supporting academic research and innovation. Subject service, in particular, refers to the professional and personalized services provided by university libraries to address the specific needs of subject construction and development. These services enable faculty and students to quickly and accurately access the resources they require, thereby improving the efficiency of teaching and research. Additionally, subject services facilitate interdisciplinary integration and foster

innovative development, providing robust information support and service guarantees essential for the success of the “double first-class” initiative ^[1].

1.2. Connotation and objectives of “double first-class” construction

World-class universities are typically characterized by outstanding teaching quality, advanced scientific research capabilities, exceptional faculty, and significant international influence. First-class disciplines are expected to achieve major breakthroughs in frontier fields, supported by leading academic teams and cutting-edge scientific research achievements. The primary objectives of the “double first-class” initiative include strengthening discipline development, enhancing social service capabilities, optimizing talent cultivation, and advancing scientific research levels. Universities are expected to attain world-class standards in areas such as discipline construction, talent development, faculty quality, research output, and international collaboration.

1.3. Connotation and characteristics of subject services in university libraries

Subject services in university libraries are designed to be subject-oriented and reader-focused, providing professional information services through close collaboration between subject librarians and readers. These services encompass subject resource development, subject-specific information consultation, subject information analysis, and subject-related training and education. Subject services are distinguished by their professionalism, personalization, proactivity, and collaborative nature. They cater to the specific needs of readers, enhance the quality and efficiency of information services, and contribute to the development and advancement of academic disciplines ^[2].

2. The “double-first-class” construction of subject services in university libraries

2.1. Construction of subject service resources

Many university libraries have developed characteristic subject resource pools by aligning with their institutions’ dominant disciplines and key majors. These resource pools encompass a wide range of materials, including academic papers, research reports, teaching courseware, case studies, and other resources related to specific disciplines. They provide strong support for the construction and advancement of academic fields. For instance, the library at Shanghai University of Science and Technology has created a specialized subject resource database covering fields such as materials science and technology, life sciences and technology, information science and technology, mathematics, entrepreneurship and management, and the humanities. This resource pool integrates cutting-edge research achievements from both domestic and international sources, expert and scholar opinions, industry trends, and other relevant information, offering a one-stop service for faculty and students.

An increasing number of university libraries are also focusing on the integration and utilization of open-access resources. By establishing navigation platforms for open-access resources and partnering with open-access institutions, these libraries provide free academic resources to faculty and students. For example, Tsinghua University Library is the only university library that has set up an open-access resource navigation platform. In November 2024, they launched the OpenSign public academic resource service platform, which classifies and organizes global open-access resources, making it easier for faculty and students to quickly locate the resources they need. Furthermore, the library actively collaborates with open-access institutions both domestically and internationally to promote the open access of academic achievements from their own institution ^[3].

2.2. Subject service mode and method

The implementation of the subject librarian system is a key factor in ensuring that university libraries can effectively provide subject-specific services. Currently, most “double first-class” university libraries have established this system, with subject librarians engaging deeply with various colleges and academic teams to understand the diverse needs of readers and meet their information service requirements. For example, at Sichuan University Library, librarians specializing in the disciplines of liberal arts, science, engineering, and medicine have developed strong relationships with faculty and researchers across different colleges. They regularly visit these colleges to assess their teaching and research needs and provide targeted information services. Subject librarians also participate in research projects within academic teams, offering information consultation and literature support to aid project development ^[4].

Embedded subject service refers to a model that integrates subject-specific services into teaching and research processes. By being incorporated into courses, research projects, and other activities, information services are delivered that are more closely aligned with the actual needs of teachers and students. For instance, at Changzhi University Library, the subject librarian assigned to the Department of Economic Management, specializing in economics, is embedded within the department. This librarian provides curriculum-related literature resources and guidance on information retrieval to students through professional teacher training. In research projects, subject librarians collaborate closely with research teams, offering comprehensive information services throughout the project’s declaration, implementation, and conclusion phases.

Additionally, some university libraries have begun exploring a data-driven approach to subject services. By analyzing reader behavior data and subject resource data, libraries can better understand readers’ needs and subject development trends, enabling them to offer more precise subject services. For example, Fudan University Library utilizes big data technology to analyze circulation records and retrieval behaviors of teachers and students, uncovering potential reader needs. This data-driven approach forms a “digital market,” allowing for the accurate recommendation of personalized books and the establishment of knowledge maps. Based on this analysis, the library is able to suggest tailored subject resources and services to readers ^[5].

2.3. Effectiveness of subject services

The subject services provided by university libraries play an essential role in supporting both teaching and scientific research. By offering abundant subject resources, conducting information literacy training, and providing research support, these services contribute to enhancing teaching quality and research productivity. For example, the subject services at Shandong University Library offer substantial teaching support to faculty members through various measures, such as information literacy education, the provision of literature resources (including the CSD crystal structure database and Nature series electronic journals), and subject services aligned with the university’s “double first-class” initiative. These services assist teachers in improving their teaching methods and enhancing educational outcomes. In the realm of scientific research, subject services provide accurate subject-specific information and literature support for researchers, promoting the generation of valuable research results.

3. Domestic and international case analysis of subject services in “double first-class” university libraries

3.1. International cases

Case 1: Subject Service Practices in Benic Rare Books and Manuscripts Library of Yale University. (1)

Features of resource construction: Benic Rare Books and Manuscripts Library at Yale University, one of the largest libraries globally, emphasizes building distinctive subject resources. It has acquired a vast collection of rare documents and specialized resources, including 180,000 rare ancient books, through collaborations with academic institutions both domestically and internationally. Additionally, the library offers an excellent learning and research environment for students and scholars through its unique architectural design and rich collections. (2) Service model innovation: The library has developed embedded subject services, with subject librarians actively involved in teaching and research to provide real-time information services. Moreover, the library leverages social media platforms for online consultations and information dissemination, enhancing the convenience and timeliness of its services.

Case 2: Subject Service Practices at the University of Pennsylvania Library (1) Success factors: The University of Pennsylvania Library excels in subject services due to its robust subject information analysis capabilities. The library has established a professional discipline information analysis team that provides substantial support for institutional discipline development and research decision-making. (2) Key learnings: The library underscores the importance of strengthening subject information analysis capabilities through practical scientific research. It provides students with top-tier teaching resources and opportunities for research guidance and collaboration. Interaction and cooperation with readers are prioritized, continuously improving service quality.

3.2. Domestic cases

Case 1: Subject Service Practices at Harbin Engineering University Library. Innovative measures: The library has implemented several innovative strategies in subject services, including the establishment of a subject service platform and efforts to build a recognizable subject service brand. The platform allows readers to conveniently access subject resources and services, significantly enhancing service efficiency and accessibility.

Case 2: Subject Service Practices at Dalian University of Technology Library. Featured service items: The library has introduced unique services, such as the *Academic Frontier Express*, dynamic updates on academic developments, and specialized subject lectures tailored to the university's academic strengths. These initiatives have been widely appreciated by faculty and students, providing substantial support for the development of disciplines and research.

Excellent domestic and international practices offer valuable lessons for advancing subject services in “double first-class” university libraries: (1) User-oriented approach: Libraries should deeply understand subject users' needs to provide personalized and accurate services. (2) Resource construction and integration: Emphasizing the development of subject-specific resources and data, while improving resource sharing mechanisms. (3) Service model innovation: Actively adopting new technologies to drive service model transformation and upgrades. (4) Team development: Focusing on cultivating and recruiting interdisciplinary talents to enhance the professionalism and innovation capacity of service teams.

4. Development strategies for “double first-class” construction of subject services in university libraries

4.1. Innovative service model

Personalized service: Big data technology is utilized to collect and analyze user behavior data, interest preferences, and other information to build user profiles. Accurate service recommendations are realized

based on the users' academic backgrounds, research directions, and reading habits, allowing relevant academic resources and research trends to be suggested. Personalized subject consulting services are provided to offer tailored solutions for users. Smart service: New technologies such as artificial intelligence (AI) and the Internet of Things (IoT) are introduced to establish a smart library service environment. Resources are automatically retrieved and acquired using intelligent equipment, while consulting services are handled by intelligent robots to enhance service efficiency and quality. A smart learning space is created to offer convenient learning and communication facilities for teachers and students, supporting discipline innovation activities. Cooperative service: Inter-library cooperation is strengthened through the establishment of a "double first-class" university library alliance, facilitating resource sharing and service coordination. Subject resource construction and joint reference consultation services are developed in collaboration with other university libraries. Additionally, partnerships are actively formed with discipline teams, research institutions, enterprises, and other entities to expand service fields and jointly conduct discipline research and innovative practices.

4.2. Optimized resource construction

Resource integration and sharing: Library collection resources, electronic resources, and network resources are integrated to build a unified resource retrieval platform, enabling one-stop resource searches. Inter-library resource-sharing mechanisms are established to provide services such as document delivery and joint lending. Participation in the construction of domestic and international academic resource-sharing platforms is encouraged to expand resource acquisition channels ^[6]. Construction of subject data resources: Investment in subject data resource construction is increased, and collaboration with subject teams is undertaken to collect, organize, and analyze subject-related data, enabling the creation of high-quality, subject-specific databases. Data standardization is emphasized, and a data quality evaluation system is established to ensure reliability and usability. Data security management is also strengthened to safeguard data security and privacy ^[7]. Dynamic adjustment of resources: A dynamic resource adjustment mechanism is established, allowing procurement strategies to be updated in line with discipline development plans, discipline evaluation results, and evolving user needs. Procurement of emerging and interdisciplinary resources is increased, optimizing the resource structure and improving resource utilization rates.

4.3. Improvement of the service effect evaluation system

A scientific evaluation index system should be constructed, encompassing multiple dimensions such as service quality, user satisfaction, and subject contribution. Service quality indicators should be established, including the accuracy and timeliness of resources and the professionalism and relevance of services. User satisfaction should be assessed through questionnaire surveys and user interviews. The subject contribution index should be evaluated based on scientific research achievements and improvements in teaching quality.

Diversified evaluation methods should be employed, integrating qualitative and quantitative approaches. In addition to traditional questionnaires and user interviews, big data analytics should be utilized to assess users' behavior data and evaluate the effectiveness of services. Peer and expert evaluations should also be introduced to enhance the objectivity and accuracy of the evaluation process.

The evaluation results should be thoroughly applied to improve services, optimize resource allocation, and assess personnel performance. Based on these results, issues in the current service delivery should be identified, and service strategies and resource allocation plans should be adjusted accordingly. The linkage

between evaluation outcomes and the performance appraisal of service personnel should be strengthened, thereby encouraging staff to continually enhance service quality.

5. Conclusion and prospects

Theoretically, the findings of this study contribute to enriching and improving the theoretical framework of library subject services and provide a theoretical foundation for the in-depth development of subject services. Practically, the research on development strategies for the “double first-class” construction of subject services in university libraries offers practical guidance for all university libraries to design scientific and reasonable service plans, ultimately enhancing service quality and efficiency. Currently, several challenges exist in the service models, resource construction, service teams, and evaluation systems associated with the “double first-class” construction of university library subject services. The primary reasons include insufficient conceptual understanding, barriers within management systems and mechanisms, and weak technical applications and innovation. Through the analysis of exemplary cases from both domestic and international contexts, this study proposes development strategies, including innovating service models, optimizing resource construction, strengthening service team development, and perfecting service evaluation systems. These strategies aim to better support discipline construction and talent cultivation in colleges and universities.

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Research Progress on the Application of BOPPPS Teaching Model in Domestic Emergency Education

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Abstract: The BOPPPS teaching model is a student-centered teaching model that has been widely applied in various teaching fields. This paper summarizes the overview of the BOPPPS teaching model, its application in emergency teaching and training, as well as its advantages and disadvantages, aiming to provide references for the further promotion and application of the BOPPPS teaching model in emergency education.

Keywords: BOPPPS teaching model; Emergency; Teaching; Training

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1. Introduction

The BOPPPS teaching model originated in the 1970s and was created by Douglas Kerr's team at the University of Vancouver. It is the primary training model used in the Instructional Skills Workshop (ISW) program for teachers in the province of British Columbia, Canada ^[1]. This teaching model is goal-oriented and student-centered ^[2], with good compatibility that can be applied to various subjects to enhance students' interest in learning and improve their self-learning abilities. Since its introduction in China, the BOPPPS teaching model has gradually been applied in medical education, and the results have shown that it is superior to traditional teaching models. It can effectively mobilize students' enthusiasm for participating in learning, benefit the improvement of students' theoretical knowledge and practical abilities, and achieve good teaching effects in both theoretical and practical teaching ^[2-5]. Emergency education is an important part of medical education. This article will review the concept, characteristics, steps, advantages, and disadvantages of the BOPPPS teaching model, as well as its application research in emergency teaching and training in China, to provide a reference for further promoting the BOPPPS teaching model and the development of emergency education in China.

2. Overview of the BOPPPS teaching model

2.1. Concept and characteristics of the BOPPPS teaching model

The BOPPPS teaching model, also known as guided interactive additive education, is an emerging teaching model that involves teachers in course design^[6]. This teaching model is based on constructivist and humanistic theories, emphasizing a student-centered approach in the teaching process^[7]. It stimulates students' interest in learning, effectively increases their participation in classroom teaching, fully leverages their subjective initiative in learning, and enhances the effectiveness of classroom teaching^[4]. This teaching model values the teaching process, focuses on constructing student participation in learning and classroom feedback sessions, and is known for its effective teaching design. It is highly operable and targeted, serving as a standard for teacher training and classroom instruction in Canadian higher education. It has also received widespread recognition from international educators and has become one of the most commonly used teaching methods in Europe and the United States^[6].

2.2. Steps of the BOPPPS model

The BOPPPS teaching model divides the classroom teaching process into six steps based on human attention characteristics: Bridge-in, Objective, Pre-assessment, Participatory learning, Post-assessment, and Summary^[8]. The BOPPPS teaching model constructs a complete teaching process and theoretical framework aimed at achieving teaching objectives, forming a closed-loop teaching unit with a complete system^[7]. The main tasks of the six steps in this teaching model are as follows^[6]: (1) Bridge-in: Introduce the teaching content, attract students' attention, and stimulate their interest in learning; (2) Objective: Clarify the learning objectives and let students understand the purpose of this knowledge; (3) Pre-assessment: Test students to understand their prior knowledge and readiness for the upcoming content, laying the foundation for subsequent teaching; (4) Participatory learning: The core step that involves students in classroom activities, guides them to actively learn, and transforms passive learning into active thinking; (5) Post-assessment: Use various methods to assess students' learning effectiveness and teachers' teaching effectiveness; (6) Summary: Conclude the course by reviewing key teaching content, summarizing knowledge points, echoing and reinforcing learning objectives, and introducing the next course.

3. Application of the BOPPPS teaching model in emergency education

3.1. Application in emergency teaching

Domestic scholars have applied the BOPPPS teaching model, either singly or combined with other teaching methods, to emergency practical or theoretical teaching. Teaching design and implementation have been carried out according to the six steps of the BOPPPS teaching model, achieving good teaching results. Lv and Zhang^[9] applied the BOPPPS teaching model to the teaching of cardiopulmonary resuscitation (CPR) skills training. The results showed that the BOPPPS teaching model can activate the classroom atmosphere, increase students' interest in learning, exercise students' language communication skills, cultivate students' active learning abilities, and improve the success rate of CPR. Deng^[10] combined the BOPPPS teaching model with simulated situational dramas and applied it to CPR teaching. The results proved that this mixed teaching model conforms to the characteristics of emergency medicine teaching and can improve students' CPR performance and teamwork ability. Lu *et al.*^[11] also applied the BOPPPS combined with situational simulation teaching model to the international course of trauma hemostasis for medical undergraduates. After the class, students' confidence in various hemostasis skills improved, and the proportion of students choosing to perform hemostasis assistance

on strangers at the first scene increased. Students' satisfaction with the course was also high. Du *et al.*^[12] conducted research on a new teaching method for hemostatic belts based on the BOPPPS teaching model and the goal of unconscious competence. They conducted theoretical lectures on hemostatic belt operation according to the BOPPPS teaching framework and designed the course based on the intensive stimulation required for the transition from unconscious incompetence to conscious incompetence, then to conscious competence, and finally to unconscious competence. Research has proven that this teaching method can improve teaching effectiveness and enhance students' hemostatic belt operation skills. Other scholars^[13,14] have also applied the BOPPPS teaching model to adult continuing education and the teaching of emergency medicine graduate students, confirming that the BOPPPS teaching model can improve student engagement, self-directed learning abilities, and learning outcomes. In addition, scholars have explored the application of the BOPPPS teaching model in ideological and political teaching of emergency courses, which has also achieved significant results. Duan^[15] explored curriculum ideological and political teaching based on the BOPPPS teaching model, combining ideological and political elements such as loving the motherland, dedication to work, and healing the sick with professional knowledge in critical illness identification, treatment, and monitoring. The results showed that curriculum ideological and political teaching based on the BOPPPS teaching method can enrich teaching content, stimulate students' interest in learning, and facilitate students' understanding of the knowledge they have learned. Shang^[16] also explored the effect of ideological and political teaching in emergency and critical care nursing courses based on BOPPPS for undergraduate nursing students. It also proved that ideological and political teaching in emergency and critical care nursing courses based on BOPPPS can improve students' course performance, teaching satisfaction, and self-directed learning abilities. Other scholars have successively explored the integration of the BOPPPS teaching model into basic life support^[17] or CPR curriculum ideological and political teaching^[18,19], confirming that the BOPPPS teaching model can promote the seamless integration of ideological and political education and professional knowledge^[19], improving students' emergency knowledge, attitudes, and behaviors to varying degrees^[17]. In summary, the BOPPPS teaching model has demonstrated its value and advantages in emergency medical education, not only improving students' abilities in multiple areas but also effectively enhancing teaching effectiveness and learning outcomes, while promoting the deep integration of ideological and political education and professional knowledge. Meanwhile, many scholars have made innovative attempts in various forms based on the BOPPPS teaching model, further expanding the application boundaries of this teaching model.

3.2. Application in emergency training

As direct parties involved in emergencies, members of the public can often provide "assistance" to the injured in the first instance while waiting for professional rescue personnel, thereby reducing disability and mortality rates. Strengthening public emergency knowledge and skills training, as well as improving social emergency training, is of great significance for increasing the survival rate and quality of life of injured patients during emergencies^[20]. However, due to variations in public cultural levels and regional customs and lifestyles, China currently lacks unified teaching materials and training methods for public emergency knowledge education, and has not yet formed a comprehensive and standardized continuing education and training model^[21]. From the forefront of research on public emergency training, it can be seen that the academic community has been committed to improving the effectiveness of public emergency training^[22], including the application of the BOPPPS teaching model in emergency training for various groups. Tan *et al.*^[23] applied the BOPPPS teaching model combined with virtual simulation technology in neonatal asphyxia resuscitation simulation training. They

verified that the combination of BOPPPS and virtual simulation technology had a good teaching effect, helping to increase learners' interest and confidence, and better grasp theoretical knowledge and operational skills related to neonatal resuscitation. Some scholars ^[24,25] also used the BOPPPS teaching model when conducting CPR training among non-medical college students, achieving positive results. The application of the BOPPPS model can enhance students' initiative in training and learning, improve theoretical and skill assessment scores and satisfaction, and effectively promote college students' confidence in CPR practice. Tao *et al.* ^[26] also applied the BOPPPS model in CPR training for non-medical personnel, finding that this training model can effectively enhance CPR training effectiveness and improve pre-hospital emergency response capabilities of non-medical personnel in hospitals, thus having high application value and being worthy of promotion and reference. Jiang *et al.* ^[27] designed and applied emergency training courses based on the BOPPPS teaching model to improve the teaching effectiveness of public emergency training. The results confirmed that such training methods can enhance public enthusiasm and initiative in emergency participation, ensuring the quality of pre-hospital emergency care. Rao *et al.* ^[28] explored training methods to improve the pre-hospital emergency skills of community general practitioners by combining the BOPPPS teaching model with the "problem-discuss-guidance" (PDG) training model. They found that this hybrid training model can create a lively learning atmosphere, effectively stimulate learners' enthusiasm, improve general practitioners' pre-hospital emergency skills, cultivate clinical thinking ability, and enhance clinical skills, thus having promotional significance in the community. Furthermore, scholars ^[29-31] have also applied the BOPPPS teaching model in emergency training for resident physicians, clinical nurses, and newly hired nurses, integrating elements such as the Mini-CEX assessment scale, scenario simulation, or problem-based learning, all achieving positive results. Participants' learning initiative and comprehensive abilities were enhanced, and their emergency theoretical knowledge and skills were also improved. In summary, the BOPPPS teaching model has demonstrated effective application in emergency training, not only improving participants' abilities in multiple areas but also enhancing their satisfaction and enthusiasm for training, ultimately achieving positive training outcomes.

4. Advantages and disadvantages of the BOPPPS teaching model

4.1. Advantages

The BOPPPS teaching model constructs a complete teaching process and theoretical framework to achieve teaching objectives. It proposes six steps centered around teaching objectives, providing a clear direction for teachers' teaching activities. This helps teachers systematically organize teaching content and ensures the logicity and coherence of the course ^[32]. The core of this model is emphasizing students' subject status, participation, and interaction. It stimulates students' interest and enthusiasm through questioning, discussion, and other methods, improving classroom participation. This active participation in the learning process helps students deepen their understanding and memory of knowledge, enhances their communication and team collaboration skills, and cultivates their innovative thinking and problem-solving abilities ^[4,5]. The "pre-assessment" step allows teachers to understand students' basic knowledge level, enabling them to adjust teaching content and methods based on students' actual situations, achieving personalized teaching. The "post-assessment" step provides teachers with an opportunity to understand students' learning effects, allowing timely feedback and guidance to help students consolidate their knowledge. This timely feedback and adjustment contribute to optimizing the teaching process and improving students' learning outcomes.

4.2. Disadvantages

The BOPPPS teaching model has high demands on teachers, requiring them to have strong teaching abilities in course design, classroom control, and student guidance during the classroom design and implementation process. If teachers lack the corresponding abilities, it may affect the final teaching effect. This teaching model consists of six steps, and each step requires a certain amount of time to implement. With limited classroom time, some steps may not be fully implemented or time allocation may be unreasonable. This requires teachers to prepare adequately before class and plan classroom time reasonably. For students accustomed to traditional lecture-style teaching, this model may pose certain challenges and discomforts. Student participation in participatory learning may be low, not meeting the expectations of the teaching plan ^[33]. Some students may need time to adapt to this new teaching model and learning style. Teachers need to pay attention to students' adaptation during implementation and provide timely guidance and assistance. Although the BOPPPS teaching model has been applied in multiple fields, it is more suitable for subjects that are more practical and discussion-focused. For more theoretical subjects, its applicability may be relatively limited. Additionally, fixed teaching steps can make the teaching model rigid and inflexible ^[32,34], hindering teachers from flexibly setting classroom sessions based on their experience and the characteristics of the teaching content. This requires teachers to continuously expand their teaching research horizons and flexibly design each teaching segment during application and research.

5. Conclusion

The BOPPPS teaching model is student-centered and teaching goal-oriented. Through six steps: Bridge-in, Objective, Pre-assessment, Participatory learning, Post-assessment, and Summary, it constructs a closed-loop teaching unit, effectively enhancing students' interest in learning, self-learning abilities, and classroom participation. This model has demonstrated significant teaching advantages and broad application prospects in domestic emergency teaching and training. To further promote the prominent role of BOPPPS teaching model in emergency education, future research and promotion can focus on the following points: strengthening teacher training to enhance their ability and level in using the BOPPPS teaching model and ensure maximized teaching effectiveness; optimizing teaching design by creating more targeted and practical teaching content and activities for different emergency knowledge and skills; deepening integration with information technology, utilizing modern technical means such as virtual simulation and online learning platforms to broaden learning channels and enhance the learning experience; and strengthening the combination with other teaching models to form a more comprehensive teaching system.

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Research on the Current Situation and Quality Improvement Strategy for University Student Party Branch Construction

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Abstract: University student Party branches serve as the Party's grassroots organizations within universities and act as a bridge and link between the Party and students. Therefore, it is essential to strengthen the development of student Party branches and enhance the effectiveness of student Party member education and training. This paper summarizes and analyzes the issues in the construction of student Party branches in universities and explores strategies for improving their quality, aiming to provide a reference for relevant personnel.

Keywords: University; Student Party branch; Quality improvement; Strategy

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1. Introduction

University student Party branches are grassroots Party organizations responsible for guiding, connecting, and uniting students. Their primary responsibilities include implementing Party policies, recruiting new members for the Party, educating and managing student Party members, and contributing to university reform and development. In the process of conducting Party-building work, universities must prioritize the construction of student Party branches, continually enhance the ideological and political education of university students, maintain the exemplary role of student Party members, and thereby promote improvements in campus culture, Party culture, and academic atmosphere.

2. Analysis of the current situation of university student Party branch construction

University student Party members are political pioneers, behavioral role models, and academic exemplars, playing a leading role in universities. In recent years, the number of university student Party members in China has increased significantly, accounting for approximately 40% of the total number of new Party members nationwide ^[1]. However, due to factors such as the challenging job market for university students and changes

in domestic and international social conditions, the construction of student Party branches in universities faces several challenges.

2.1. Issues in the establishment of Party organizations and the education and training of Party member cadres

With the expansion of university enrollments, the overall number of student applicants for Party membership and Party members has grown significantly. At the same time, several issues in student Party branch construction have surfaced. It has become common for Party member cadres to hold multiple roles, and due to time and energy constraints, some cadres fail to fulfill their responsibilities, affecting the progress of Party-building work. Moreover, many student Party cadres lack sufficient work experience, theoretical knowledge, and management skills to meet the demands of Party-building tasks. This shortfall impacts areas such as the cultivation of probationary members and active applicants, as well as ideological and political education, thereby hindering the smooth development of student Party membership initiatives ^[2].

2.2. Overly utilitarian motives for joining the Party among some students

Some university students have overly utilitarian motives for joining the Party, viewing Party membership as a means to improve themselves or enhance their comprehensive abilities, or as a pathway for personal advancement. Some students mistakenly believe that joining the Party provides political capital or tangible benefits, treating it as an effective route to securing government jobs or graduate school placements. Such attitudes reflect a lack of Party consciousness and weak determination, which can adversely affect the overall image of student Party members.

2.3. Problems in the implementation of the Party branch system and continuing education for party members

Some university student Party branches fail to strictly enforce systems for member evaluation, supervision, education, and promotion. Insufficient emphasis on the re-education and evaluation of active Party applicants negatively affects the discipline and rigor of the Party membership development process ^[3]. Additionally, while some student Party branches focus on pre-membership education for development candidates, they lack comprehensive post-membership continuing education programs. As a result, some student Party members experience a decline in political awareness, reduced sense of responsibility, and weakened Party discipline.

2.4. Issues in the form and content of Party-building work

In the current era of information and the internet, student Party branch construction in universities must make reasonable use of various online platforms to actively promote Party policies and implement Party affairs transparency to improve the overall quality of Party-building efforts ^[4]. However, some universities underinvest in student Party branch construction, with Party-building websites poorly maintained, content updates slow, and the forms and content of Party-building work too monotonous to meet students' needs.

3. Quality improvement strategies for university student Party branch construction

3.1. Innovating and improving the construction model of student Party branch and strengthening training and education for party members and cadres

In the process of building student Party branches in universities, it is essential to adhere to the core concept

of student-centeredness. Universities should innovate and improve the development models of student Party branches, tailored to the specific conditions of student Party members in various colleges, ensuring that Party-building work extends to every class for seamless integration. For instance, in colleges with a larger number of student Party members, Party branches can be established by grade or class. In colleges with fewer Party members, institution-level Party branches can be established to expand the coverage of Party-building work. Universities should also regularly organize training sessions for student Party cadres to explain Party-building principles, processes, methods, and basic requirements, as well as to disseminate specialized knowledge on Party affairs. This training aims to improve the political theoretical level of student Party cadres, enhance their organizational and management skills in Party-building work, and assess them post-training. Outstanding student Party members with strong Party spirit, comprehensive qualities, upright conduct, and strong abilities, who are also well-regarded by their peers, should be appointed as key cadres within the Party branch ^[5]. Additionally, universities should address the issue of Party cadres holding multiple positions by clearly defining the responsibilities of student Party branch secretaries and committee members. This clarity fosters synergy between the two roles, thereby enhancing the combativeness and cohesion of student Party branches and elevating the overall level of Party-building work in universities.

3.2. Strengthening ideological and political education and strictly reviewing students' motives for joining the Party

Universities should intensify efforts in ideological and political education for college students by diversifying the methods of education. Through ideological and political theory courses, seminars, symposiums, lectures, and social practice, universities can provide comprehensive, diverse, and multi-tiered ideological and political education. This approach aims to enhance students' political theoretical level and moral qualities, equipping them with firm political stances, patriotism, and national spirit ^[6]. Moreover, universities need to address the inconsistency in the intensity of education before and after students join the Party by significantly strengthening the re-education of student Party members. This involves improving educational methods and content, organizing student Party members to engage with grassroots workers and farmers, and involving them in various social practice activities. Such activities educate them and develop their skills, continually enhancing their sense of service. Furthermore, universities should standardize students' motives for joining the Party through peer education, positive guidance, and self-education. By combining explicit and implicit evaluation methods, such as teacher interviews, recommendations by youth organizations, public supervision, regular evaluations, and branch voting, universities can rigorously review the motives of prospective Party members. They should strictly assess applicants' Party spirit and political awareness, eliminating improper motives for joining the Party and ensuring the advancement and purity of the student Party membership team.

3.3. Constantly improving the relevant system of party branches and standardizing the party member development process

The development of university student Party branches requires the support of relevant systems. To this end, universities need to establish and improve management systems, work systems, life systems, and learning systems in line with actual conditions. Considering the learning and living characteristics of student Party members, universities should also establish and refine systems such as democratic evaluation, heart-to-heart talks among Party members, Party-member-mass connection systems, excellence and innovation systems, and public announcement systems for Party member development. These systems ensure that each aspect of student

Party branch development has clear institutional support, guaranteeing the standardization and effectiveness of related work. Universities should also regularly organize training activities on institutional protocols, helping student Party members recognize the authority of these systems and encouraging their conscious adherence. Furthermore, universities need to standardize the Party member development process by aligning with the requirements of the Party Constitution, clearly defining conditions for Party membership, and cautiously developing new Party members. By improving the foundational structure of the Party membership team and raising the overall quality of members, universities can enhance the vitality and progressiveness of student Party branches. Universities must rigorously assess active applicants and probationary Party members, admitting advanced individuals with proper motives, firm ideals and beliefs, and a dedication to serving the people. This approach strengthens the progressiveness and vitality of university student Party branches ^[7].

3.4. Constantly improving the form and content of university student Party branch construction

Currently, China has fully entered the era of information and the internet, and traditional Party-building work models can no longer meet the practical needs of university students. Therefore, it is necessary to fully utilize online platforms to develop student Party branches in universities, enriching the forms and content of Party-building work and enhancing its interactivity and service orientation. First, universities need to increase their emphasis on online Party-building work by investing more financial and human resources. They should establish sections on online platforms for Party affairs management, news releases, and monitoring the ideological trends of Party members. Building an online Party school and actively incorporating Party and national policies into these platforms will enable the online Party-building platform to serve as a hub for information dissemination, promotion, learning, services, and interaction. This, in turn, will promote the continuous improvement of the quality of student Party branch construction. Second, universities should thoroughly analyze the specific characteristics of student Party members and tailor the content of online Party-building work to their needs and interests. Dedicated sections for online interaction, student Party member forums, and the sharing of learning experiences should be established. This ensures that university students benefit from engaging with the online Party-building platform. Third, universities should focus on establishing a comprehensive system for online Party-building work and making necessary adjustments during its implementation. They should also enhance the technical support for online Party-building, strengthen administrative management, and effectively integrate online and offline Party-building efforts. This approach will meet the diverse needs of students, help them understand Party-building content correctly, and comprehensively improve the overall quality of Party-building work.

4. Conclusion

The construction of student Party branches in universities can significantly impact the reform and development of universities and the personal growth of students. Therefore, it is crucial to continuously improve the quality of this work, enhance its methods, and refine its content. At present, there are many challenges in the construction of student Party branches in universities. Addressing these challenges requires innovative improvements to the construction model, strengthening the training and education of Party cadres, intensifying ideological and political education, strictly reviewing students' motivations for joining the Party, continuously refining relevant systems, standardizing the Party membership development process, and enhancing the forms and content of student Party branch construction in universities.

Disclosure statement

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Discussion on the Construction of Part-Time Teachers in Higher Vocational Colleges

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Abstract: High-quality professional teaching staff is an important guarantee to achieve high-quality sustainable development of higher vocational colleges. Part-time teachers are an essential part of the teaching staff of higher vocational colleges, playing a vital role in higher vocational education. This paper analyzes the problems existing in the management of part-time teachers in higher vocational colleges, such as irregular employment, lack of systematic training, imperfect teaching quality monitoring and evaluation system, weak incentive policy, high turnover, and poor stability. Combined with the characteristics of part-time teachers, this paper explores the construction strategy of part-time teachers in higher vocational colleges, builds a high-quality and high-level part-time teacher team, and provides references for achieving high-quality sustainable development of higher vocational colleges.

Keywords: Higher vocational school; Part-time teachers; Countermeasures

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1. Introduction

Developing new quality productivity is an inherent requirement and an important focus for promoting high-quality development. The first element of the new quality productivity is the new type of workers, strategic talents, and applied talents who can master the new labor tools and continuously create new labor objects. As a vocational education with a high degree of isomorphism with economic and social development, we should comprehensively understand and deeply grasp the rich connotation and practical requirements of new quality productivity, and build a high-quality labor team that adapts to the progress of modern science and technology and the development of modern industry. In order to continuously improve the adaptability of the service industry, higher vocational colleges also urgently need more first-line engineering and technical personnel, highly skilled personnel, management personnel, skilled craftsmen, etc. to participate in talent training and strengthen the construction of high-quality part-time teachers. In recent years, society has put forward new and higher requirements for the construction of part-time teachers in higher vocational colleges, but in practice, the

high-quality development of part-time teachers in higher vocational colleges is still faced with many realistic difficulties, which cannot fully meet the new situation and requirements of the construction of a strong country. Therefore, it is necessary to strengthen the construction of part-time teachers in higher vocational colleges.

Currently, the theoretical expertise of teachers in higher vocational colleges in China is relatively strong. However, many lack practical work experience, leaving them unable to address industry-specific problems effectively. This gap hinders the improvement of professional teaching quality. Recognizing the importance of part-time teachers, higher vocational colleges are prioritizing their management and development. To address the shortcomings of traditional part-time teachers and optimize faculty composition, it is imperative to strengthen the construction of part-time teaching teams and promote their standardization.

Research on the development of part-time teachers in higher vocational colleges has yielded some notable results. To compensate for the shortage of teaching resources, many institutions hire part-time teachers. Zhang ^[1] argued that the unique characteristics of part-time teachers could negatively impact teaching quality and outcomes. He emphasized the importance of building a high-quality teaching workforce in higher vocational colleges and proposed exploring standardized management strategies tailored to the roles of government departments and part-time teachers. Zhang ^[2] examined the significance of developing part-time faculty and identified several issues in their current management, including irregular employment practices, lack of systematic training, an underdeveloped quality monitoring and evaluation system, weak incentive policies, high turnover rates, and poor job stability. He proposed several measures to improve part-time teacher management, such as reforming employment systems, providing systematic training, enhancing quality monitoring and evaluation mechanisms, strengthening incentive policies, and fostering better communication. These measures aim to improve the quality of part-time teachers, enhance the teaching standards of higher vocational colleges, and support their sustainable development. He ^[3] explored the innovative “school-enterprise community” model as a cooperative mechanism for developing part-time teachers. This approach offers practical guidance for building an efficient, collaborative, and socially integrated education ecosystem. It holds significant potential for optimizing resource allocation, improving teaching effectiveness, and advancing the integration of industry and education.

2. Vocational characteristics of part-time teachers in higher vocational colleges

At present, most part-time teachers in higher vocational colleges come from industry as skilled craftsmen or technical experts, embodying dual professional characteristics. These teachers possess extensive professional knowledge and practical skills, along with experience working in enterprises. However, they typically have limited teaching experience, employ relatively simple instructional methods, lack interaction with students, and have insufficient collaboration and communication with full-time teachers ^[4]. Due to the nature of their vocational roles, part-time teachers often face scheduling changes, leading to unstable class times. Their high mobility poses challenges for teaching management and curriculum planning. Moreover, their primary professional responsibilities outside the college limit the time and energy they can dedicate to part-time teaching. This results in minimal effort invested in course preparation and delivery, contributing to inconsistent teaching quality in professional courses. Given these vocational characteristics, it is essential to strengthen the development of part-time teachers, leverage their industry expertise, and align their contributions with the needs of professional teaching development.

3. Problems existing in the management of part-time teachers in higher vocational colleges

3.1. Imperfect employment system and uneven teacher quality

The recruitment of part-time teachers in many higher vocational colleges remains passive, often driven by shortages in specific majors or courses. These institutions commonly rely on public recruitment or recommendations through personal networks. However, due to time constraints, the qualifications and expertise of part-time teachers are not always thoroughly assessed during the hiring process. This results in variability in their skills and teaching quality, ultimately affecting the overall standard of education.

3.2. Lack of perfect supervision and management mechanisms

Part-time teachers, who generally hold full-time jobs elsewhere, exhibit high mobility and low stability. Unfortunately, many higher vocational colleges lack effective mechanisms for regulating and supervising their work, relying heavily on the teachers' self-discipline and sense of responsibility ^[5]. The absence of rigorous oversight often leads to insufficient attention to teaching responsibilities, inadequate assessment of teaching quality, and challenges in maintaining consistent educational outcomes. While colleges may organize lectures for part-time teachers and provide feedback, such initiatives rarely form a basis for meaningful improvements. As a result, the existing supervision and management frameworks for part-time teachers are largely perfunctory and lack practical significance.

3.3. Lack of systematic training and weak sense of belonging

Few higher vocational colleges have established systematic and standardized training programs for part-time teachers. Although these external teachers bring substantial professional knowledge and hands-on skills, their teaching methodologies often need enhancement through targeted training. Unfortunately, many colleges pay insufficient attention to this need. Additionally, part-time teachers' compensation is typically calculated based on class hours, excluding them from opportunities for title evaluations, awards, or recognition. This exclusion fosters a perception among part-time teachers that they are peripheral to the institution, leading to a lack of connection to its interests and achievements. Consequently, they often exhibit a weak sense of belonging, which affects their dedication to teaching. This detachment results in limited responsibility and engagement with their teaching duties. Many part-time teachers aim only to fulfill their contractual obligations, with little attention to teaching outcomes—an approach that hinders the development of professional education.

4. Countermeasures for standardized management of part-time teachers in higher vocational colleges

4.1. Improving the employment system and assessing part-time teachers

Vocational colleges should establish a standardized management system for part-time teachers. First and foremost, a comprehensive employment system for part-time teachers should be developed and refined. During the hiring process, emphasis should be placed on assessing candidates' professional knowledge, qualifications, skills, and teaching abilities. Based on national teaching quality standards for related disciplines, professional standards for part-time teachers in higher vocational colleges, curriculum standards for teacher education, and teacher certification requirements, colleges should formulate training objectives, define job responsibilities, and establish expectations for part-time teachers. Key assessment criteria should include part-time teachers' educational beliefs, professional ethics, knowledge structure, teaching ability, class management, holistic

education practices, self-planning and professional development, as well as communication and collaboration skills. Colleges must prepare and refine teaching documentation, including teaching plans, classroom organization guidelines, course assessments, grade evaluations, and procedures for collecting teaching archives and conducting performance reviews ^[6]. All part-time teachers should uphold moral education as a foundation, adhere to teaching standards, enhance their information-based teaching capabilities, prepare thoroughly for classes, deliver quality instruction, and educate students with integrity. They are also encouraged to leverage their industry expertise and professional advantages to introduce advanced technologies and resources into the classroom, contributing positively to improving the quality of vocational training. By continuously enhancing the employment system, colleges can ensure that part-time teachers meet the professional competence and quality standards required for high-quality instruction in their respective disciplines.

4.2. Strengthening supervision and management mechanisms to achieve standardized management

Building a strong teaching team is an enduring priority for school development. Following the principle of “operating schools lawfully and in a standardized manner,” schools have gradually established teaching teams with appropriate scale and structure to meet instructional needs. With part-time teachers now forming a significant proportion of teaching staff, it is essential to enhance their supervision and management. Vocational colleges should strictly follow institutional guidelines for hiring and managing part-time teachers. Relevant departments should ensure proper daily management, establish comprehensive personnel files for part-time teachers, and rigorously implement supervision systems to ensure compliance with standardized practices. These efforts will ensure the effective integration of part-time teachers into the academic framework.

4.3. Enhancing welfare policies to foster a sense of belonging

To strengthen the development of part-time teaching staff, vocational colleges should improve welfare policies, thereby enhancing part-time teachers’ sense of achievement and belonging. A robust policy framework should ensure fair salaries and benefits, motivating teachers to inspire greater enthusiasm among students and provide more professional insights during lessons. Course presentations and evaluations should also be conducted at the end of each course. Additionally, ideological education for part-time teachers is essential to deepen their understanding of their roles and responsibilities, including course design and innovative teaching practices. School management should actively engage with part-time teachers to address challenges and concerns, emphasizing teaching standards and expectations. This collaborative approach enhances their sense of responsibility and belonging, driving improvements in course quality and professional development. Humanistic care and consistent communication between teaching units and part-time teachers can further strengthen their connection to the institution. Such initiatives improve job satisfaction and encourage part-time teachers to actively contribute to professional and curriculum development.

5. Conclusion

Strengthening the development of part-time teaching staff is essential for higher vocational colleges in the modern era. Institutions must recognize the importance of this initiative, consider the unique characteristics of part-time teachers, and develop targeted strategies to address challenges in their management. This approach will help optimize the role of part-time teachers in vocational education and enhance the overall quality of teaching and learning.

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Construction of a Golden Course for Advanced Mathematics by Integrating Course Ideological and Political Education

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Abstract: In this paper, the necessity of constructing a golden course for Advanced Mathematics is presented. For teachers, golden courses enhance their teaching ability and job satisfaction. For students, golden courses improve their sense of learning value and significance and encourage them to actively learn and participate deeply. Next, the relevant content of course ideological and political construction is provided. Finally, a specific approach was proposed to create a golden course for Advanced Mathematics by integrating ideological and political education into the curriculum.

Keywords: Curriculum ideological and political education; Advanced Mathematics course; Golden courses

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1. The necessity of creating a golden course for Advanced Mathematics

The reform of higher education is essential. The prelude to higher education reform has already begun. In such an environment, how to carry out curriculum reform to adapt to development is inevitably a problem that must be solved. Universities should change their traditional teaching methods, break through old educational approaches, and change their original thinking patterns. Using new ideas, education systems, learning systems, and thinking patterns, we pre-determine professional and employment directions and integrate the two^[1,2]. As a basic course, Advanced Mathematics is the foundation of other professional courses, as well as the theoretical basis for digesting and absorbing other professional courses. It plays a critical role in the learning of subsequent courses and the cultivation of students' logical thinking ability. In order to keep up with the current needs of society, this course requires curriculum reform to develop.

Creating "golden courses" is a systematic project that requires top-level design and grassroots innovation^[3,4]. The "Internet+" class has shown great advantages. The unprecedented tremendous impact of new technologies will trigger a fundamental transformation in the classroom of basic courses. The classroom format is transformed from "quiet" teaching to "dialogue," "criticism," and "debate."

2. Course ideological and political construction

Course ideological and political education is the integration of ideological and political elements into classroom teaching in universities ^[5,6]. Course ideological and political education is the process of imparting knowledge and cultivating skills, while quietly interweaving and integrating ideological and political elements, gradually cultivating students' correct three perspectives—worldview, values, and outlook on life. Only in this way can the educational function be exerted in the teaching of universities, reflecting the essential connotation of ideological and political education in the curriculum, and thus creating a golden course for Advanced Mathematics ^[7].

2.1. Measures for course ideological and political construction

Teachers deeply explore the mathematical culture inherent in the curriculum and the development history of higher mathematics education, used as materials for ideological and political education in the curriculum. These are integrated into teaching to achieve educational goals. In teaching, we can combine mathematical knowledge and strive to deeply explore the beauty, philosophy, and spirit of mathematics contained in mathematical courses, providing students with silent ideological and political education.

Teachers carry out teaching and research activities on course ideological and political construction, especially inviting course ideological and political teachers to participate in course ideological and political teaching and research activities. A team of ideological and political teachers should be formed. Teachers also conduct post-class reflection and self-evaluate the actual results.

2.2. Effectiveness of course ideological and political construction

Teachers actively explore ideological and political elements in the curriculum and seek the best entry point to integrate them into classroom teaching, in order to achieve better educational effects.

By participating in various skill competitions, micro course competitions, and course ideological and political competitions organized by the school, teachers can achieve good rankings and promote construction through competitions.

Teachers also pay attention to the accumulation of relevant information and download academic papers, teaching materials, and teaching videos related to ideological and political education courses. They actively participate in course recording to achieve collective completion of lesson plans with ideological and political education courses.

2.3. Problems and improvement measures in course ideological and political work

2.3.1. Weak foundation of ideological and political education

The foundation of ideological and political education is weak, requiring improvement and enhancement. The ideological and political attributes of the course and the exploration of ideological and political resources are not comprehensive enough.

To solve this problem, the teaching content, pace, and mode of the course are controlled and adjusted by the instructor. The quality and efficiency of teaching are closely related to teachers' teaching ability and levels. It can be seen that in promoting the process of ideological and political education in the curriculum, efforts should be made to increase the training of teachers. Schools need to conduct relevant training on exploring the intrinsic connection between ideological and political courses and mathematics courses, as well as the ideological and political elements in the courses, both online and offline.

2.3.2. Lack of awareness of self-improvement and development among teachers

Teachers lack the awareness of self-improvement and development in terms of their skills and knowledge. To solve this, when carrying out self-improvement, teachers should avoid only focusing on strengthening professional knowledge reserves to improve professional teaching ability and level. The importance of cultivating one's own ideological and political literacy should not be overlooked. Teachers should actively learn relevant ideological and political knowledge and improve course ideological and political abilities. This can enhance subjective willingness and avoid making the construction of ideological and political courses superficial.

2.3.3. Poor integration of ideological and political education with curriculum content

The integration of ideological and political education and curriculum content is poor and there is a phenomenon of rote application. To improve this situation, teachers need to have a clear understanding of the objectives and requirements for the ideological and political education content in the curriculum. The implementation of ideological and political education goals should be clarified in the classroom, as well as the study objectives in terms of knowledge and skills. For instance, the combination of Sizheng Cheng elements and the effectiveness of course ideological and political education. It is necessary to clearly identify the parts with ideological and political content in the lesson plan, and provide personalized prompts or annotations. Reflection and summary should be conducted after class.

3. Specific methods to construct a golden course for Advanced Mathematics by integrating course ideological and political construction

3.1. Establishing goals for ideological and political education

Based on the concept of ideological and political education in Advanced Mathematics courses, goals for ideological and political education in courses should be established.

Taking Calculus as an example, its ideological and political education goals are set as follows: Calculus, as a general education course, has a large number of class hours and wide coverage. Teachers should combine their own work experience and profound understanding of mathematics to discuss how to combine knowledge transmission with value guidance from the aspects of spreading mathematical culture and explaining mathematical philosophy and life value. This is to cultivate a positive and optimistic attitude towards life among students and enable students to deeply understand the importance of mastering and applying mathematical methods. The thoughts, viewpoints, contributions, rigorous scholarship, the spirit of hard work, overcoming difficulties, and pursuit of the truth of mathematicians have a positive impact on the personal moral consciousness and conduct of students. It can cultivate and enhance the ideological and moral character of students. This enables students to understand the dialectical opposition and unity between the local and the whole, the process and the result of change, and to adopt a thinking method and approach.

For example, the courses Linear Algebra and Probability Theory and Mathematical Statistics have the following ideological and political education goals: theoretical completeness, strong abstraction, rigorous logic, and a wide application range of the courses. It is now concise and standardized in its internal structure and is reflected in its strong applicability and ease of operation externally. Exploring the beauty of mathematics can not only help students understand the utility of mathematics, but also cultivate their excellent mathematical spirit and enhance their aesthetic ability. Many theorems and formulas are named after people, which instills in students a spirit of courage to struggle, fearlessness of difficulties, continuous exploration, and the pursuit of

truth, promoting the importance of integrity. On the basis of learning the course content, students can establish a correct outlook on life and values and sense of social responsibility, national pride, and patriotism, achieving moral education and cultivating people.

3.2. Exploring ideological and political elements by chapter

Each chapter delves into the content that can introduce ideological and political elements into the curriculum. Teachers use knowledge points as a medium to make mathematics classroom teaching an important channel for introducing ideological and political education into the curriculum. This can gradually stimulate students' interest in ideological and political education in the curriculum and cultivate students' sense of social responsibility and patriotism.

3.3. Proposing requirements for the teaching methods of ideological and political education in the curriculum

Integrating ideological and political education into higher mathematics curriculum teaching aligns various courses with ideological and political courses. Integration of explicit education and implicit education forms a synergistic effect. Schools should build a comprehensive and all-round education system for all employees. Deepening the exploration of ideological and political elements in Advanced Mathematics courses is an important link in deepening the ideological and political reform of the curriculum.

For teachers, “golden courses” enhance their teaching ability and job satisfaction. More compulsory general education courses should develop into high-quality courses. For students, “golden courses” improve their sense of “learning value” and “meaning,” encouraging them to actively learn and participate deeply. By integrating the construction of ideological and political education into the curriculum, we will ultimately create a golden course for Advanced Mathematics. There is an educational atmosphere for both in-class and out-of-class learning and practical activities. Integrating ideological and political elements naturally into the teaching of the curriculum allows students to immerse themselves in the ocean of knowledge while experiencing warmth and positivity.

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Application of Artificial Intelligence Technology in Teaching Supervision for Vocational Education

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Abstract: This study explores the application of artificial intelligence-based teaching supervision systems in vocational education, addressing challenges in traditional teaching and supervision. The system leverages real-time monitoring, behavior recognition, and data analysis to enhance teaching quality and management efficiency. A case study demonstrates significant improvements in student engagement, discipline, and personalized learning outcomes, with classroom interaction rates increasing by 25% and discipline issues decreasing by 40%. Despite challenges in accuracy, data storage, and ethical concerns, the integration of advanced technologies like virtual reality and blockchain offers promising potential for intelligent, data-driven educational models and quality improvement.

Keywords: AI-based teaching supervision; Vocational education; Real-time monitoring; Behavior recognition; Data-driven education

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1. Introduction

In vocational classroom teaching, traditional teaching methods and management approaches face numerous challenges. The artificial intelligence (AI)-based teaching supervision system, leveraging behavior recognition and real-time data analysis, has significantly enhanced teaching quality and management efficiency in vocational education. This paper explores the core functions of this system, compares it with traditional supervision methods, and highlights its comprehensive advantages, aiming to promote the intelligent transformation of vocational education ^[1].

2. Challenges in vocational classroom teaching

2.1. Issues with student behavior in class

Many vocational education students exhibit a lack of interest in their courses, leading to low engagement and poor learning outcomes. In some cases, these issues may escalate to disciplinary problems. Classroom discipline

challenges are common in school education and can significantly undermine the effectiveness of teaching and diminish students' overall learning experiences.

2.2. Issues with teacher practices in the classroom

2.2.1. Insufficient teacher-student interaction

A lack of teacher-student interaction occurs when engagement between educators and learners is minimal during classroom activities ^[2]. This often results in students failing to actively participate in discussions, ask questions, or provide feedback. Consequently, it diminishes the dynamic exchange crucial for effective learning and limits students' involvement and understanding.

2.2.2. Delayed teaching feedback

Delayed teaching feedback refers to the inability of teachers to provide timely and effective responses to students' learning processes ^[3]. Additionally, teachers may not monitor or address students' performance and learning states promptly. This delay not only hampers students' academic progress but can also lead to misunderstandings of course content, ultimately compromising their learning outcomes.

2.3. Limitations of traditional classroom supervision

2.3.1. Coverage limitations of manual supervision

Traditional classroom supervision relies on periodic inspections, evaluations, and observations by teaching management staff to ensure teaching quality and classroom order ^[4]. However, this manual approach has significant limitations, particularly in large-scale teaching environments. Challenges such as insufficient staff, limited time and frequency for supervision, and restricted coverage of classes and teachers often lead to incomplete or subjective feedback. These constraints reduce the accuracy and reliability of classroom evaluations.

2.3.2. Unsophisticated data collection and analysis

Another significant limitation of traditional classroom supervision lies in the unsystematic nature of data collection and analysis. Manual supervision often depends on educators' observations, records, and feedback, which are prone to fragmentation, subjectivity, and incompleteness. The lack of systematic data gathering and analysis can result in inaccurate evaluations of teaching quality. Additionally, traditional data collection methods often focus on the overall class performance while neglecting individual students or specific groups. As a result, specific issues faced by individual students or teachers may go unnoticed and unaddressed.

3. Characteristics and advantages of the AI-based teaching supervision system

The rapid development of AI technologies offers innovative solutions for classroom teaching management in vocational education ^[5]. The AI-based teaching supervision system leverages behavior recognition, real-time data collection, and intelligent analysis to achieve precise monitoring and feedback for classroom activities.

3.1. Core functions of the system

3.1.1. Behavior recognition and anomaly detection

The AI system employs technologies such as sensors, cameras, and audio analysis to monitor, analyze, and identify the behaviors of teachers and students in real time. This enables the system to detect and address

anomalies promptly, optimizing the teaching process and improving teaching quality. For instance, using behavioral analysis models, the system can recognize teaching behaviors, classroom management strategies, and interaction patterns while simultaneously recording students' engagement levels and behavioral states, ensuring standardized classroom practices.

3.1.2. Real-time data analysis and feedback

By collecting and analyzing multidimensional data in real time, the system generates feedback that helps teachers and administrators adjust their teaching strategies promptly. During supervision, the system monitors data on teacher-student interactions, classroom discipline, emotions, and learning progress. Using big data analytics and machine learning techniques, the system processes and analyzes these inputs in real time, providing valuable insights and feedback to optimize teaching processes.

3.2. Comparison between AI systems and traditional supervision

3.2.1. Differences in operational modes

The AI system utilizes real-time monitoring and multidimensional data collection—such as video analysis and behavioral monitoring—to comprehensively capture classroom information, including teacher and student behaviors as well as discipline. It generates analytical reports quickly using big data and machine learning, offering immediate insights for classroom improvement. In contrast, traditional manual supervision relies on human observation during periodic classroom visits, which is prone to subjective bias, fails to capture detailed information, lacks real-time data, and requires long analysis cycles, hindering the ability to make immediate adjustments.

3.2.2. Advantages in efficiency and precision

Through real-time monitoring and data analysis, the AI system provides immediate feedback on classroom dynamics, including student engagement and emotional changes, along with targeted recommendations. This greatly enhances teaching flexibility and responsiveness. Additionally, the data processing capabilities of the AI system far surpass those of manual supervision. It can analyze vast amounts of data, conduct in-depth multidimensional investigations into classroom behavior and emotional changes, and deliver comprehensive and precise feedback.

3.3. Comprehensive advantages of AI technology

3.3.1. Enhancing classroom engagement

Through intelligent analysis, real-time feedback, and personalized interventions, AI technology significantly improves classroom efficiency and quality. The system monitors student behavior in real time, tracks classroom participation, and generates reports to prompt teachers to engage less active students. Based on participation data, AI provides recommendations, such as incorporating questions or interactive activities, to spark students' interest and enhance their engagement. Using facial expression recognition and voice analysis, the system can also monitor students' emotional states, identifying signs of fatigue, anxiety, or boredom. Combining emotional and interest data, AI offers personalized teaching suggestions.

3.3.2. Supporting improved teaching decision-making

AI technology supports precise teaching decisions through data analysis and real-time feedback. For example, by analyzing classroom performance and evaluating learning outcomes, the system helps teachers understand

each student's learning progress and identify those struggling or falling behind. Quantitative feedback enables teachers to adjust teaching methods to better meet student needs, ensuring more effective and inclusive instruction.

4. Implementation and effectiveness of the AI-based teaching supervision system

4.1. System design and architecture

The design of the AI-based teaching supervision system is centered on modularity and high integration, supporting real-time monitoring, data processing, and intelligent feedback. Utilizing deep learning algorithms, the system can analyze behavioral patterns and emotional states of both teachers and students in real time, providing crucial insights for classroom feedback. Additionally, the system integrates data on behaviors, emotions, and the classroom environment to generate comprehensive reports. These reports include metrics such as student engagement, teaching pace, and discipline scores, allowing for multi-dimensional classroom analysis.

Based on real-time monitoring results, the system delivers feedback and teaching adjustment suggestions to teachers via a dedicated interface, enabling instant optimization of classroom strategies. Furthermore, teachers and administrators can customize data displays and use built-in tools to design personalized teaching plans according to their specific needs.

4.2. Case study analysis

4.2.1. Case background and deployment plan

Guangxi Vocational and Technical College of Water Resources and Electric Power, a school specializing in training high-quality professionals in the water and power sectors, deployed the AI teaching supervision system based on an analysis of student performance.

The deployment process included:

- (1) Hardware setup: Classrooms were equipped with high-definition cameras, environmental monitoring sensors, and audio collection devices to ensure comprehensive data coverage.
- (2) Platform development: A cloud server integrated data transmission and processing functionalities, establishing platforms for teachers and administrators. Teachers received real-time feedback, while administrators accessed teaching quality reports.
- (3) Pilot testing and expansion: Initially, the system was piloted in five classrooms to evaluate performance and collect data. Following successful evaluation, the deployment was scaled to cover the entire campus.
- (4) Training and adaptation: Training sessions were conducted to ensure that teachers and administrators could effectively operate the system, interpret data, and apply feedback.

4.2.2. Improvement in classroom performance

The implementation of the AI teaching supervision system resulted in significant improvements in classroom management and teaching quality, particularly in:

- (1) Student engagement: Student participation improved markedly, with the number of students actively answering questions increasing by 30% on average in pilot classrooms, and classroom interaction rates rising by 25%.
- (2) Discipline management: The system's ability to detect and provide immediate feedback on disruptive

behaviors (e.g., phone usage, inattentiveness) helped teachers correct issues promptly, reducing classroom discipline problems by 40%.

- (3) Teaching adjustments: Teachers who adjusted their strategies based on AI feedback saw a 15% increase in knowledge retention rates, especially in challenging subjects such as mathematics and physics.
- (4) Personalized teaching: AI-generated personalized learning suggestions led to a 20% improvement in student satisfaction, with classrooms becoming noticeably more dynamic.
- (5) Management efficiency: Administrators gained faster insights into class and teacher performance through system reports, reducing classroom inspection frequency by 50% and increasing resource allocation efficiency by 30%.

5. Limitations and future prospects of the AI teaching supervision system

While the AI system has demonstrated remarkable success in improving teaching quality, certain technical and ethical challenges remain:

- (1) Accuracy and reliability: The system's performance relies heavily on high-quality data collection and analysis. In complex teaching scenarios, it may struggle to accurately identify and interpret diverse student behaviors.
- (2) Data processing and storage: The system requires substantial computational resources and storage capacity. Any technical failure or data loss could disrupt the continuity and effectiveness of teaching processes.
- (3) Ethical concerns: Over-reliance on AI monitoring may lead to students feeling overly surveilled, potentially impacting their classroom behavior and psychological well-being.

Future developments could integrate technologies such as virtual reality (VR) and blockchain to create a more intelligent and secure teaching environment. Continued optimization of algorithms and enhanced privacy protection mechanisms will improve system stability and user acceptance. Moreover, deeper integration of AI technologies with vocational education can drive teaching model innovation, building data-driven systems for teaching evaluation and improvement. This will provide new momentum for elevating the quality of vocational education.

6. Conclusion

The AI-based teaching supervision system significantly enhances the efficiency and scope of classroom monitoring through real-time observation, behavior recognition, and data analysis. By providing actionable teaching suggestions, it addresses classroom challenges effectively. As vocational education evolves toward intelligent and personalized learning environments, the potential for AI systems in teaching management is immense. Integrating AI with advanced technologies like VR and blockchain, combined with algorithm optimization and robust privacy protections, will further enhance system reliability and user trust. This deep integration will propel teaching model innovation, fostering data-driven evaluation systems and contributing to the comprehensive improvement of vocational education quality.

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Research on Teaching Strategies of Kindergarten Nature Education Course for Preschool Education Majors in Colleges and Universities

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Abstract: Nature education program is an essential teaching content in kindergarten, which is not only conducive to enhancing children's knowledge of the natural environment and awareness of protection but also cultivating their exploratory ability. As the future practitioners of kindergarten education, preschool education majors in colleges and universities are now actively exploring the implementation strategies of kindergarten nature education programs and innovating the construction method of nature education programs, which not only directly affects the high quality of their future teaching work, but also helps to promote the cognitive development of young children and the enhancement of their practical skills. Based on this, this paper outlines the teaching strategies of a kindergarten nature education program from the perspective of letting young children get close to nature, discovering nature, and other aspects of preschool education majors in colleges and universities.

Keywords: College preschool education majors; Nature education program; Teaching strategies

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1. Introduction

The core of the kindergarten nature education program is to guide young children to understand and learn about nature through hands-on experience or observation, which can enrich young children's cognition, increase their insights, and promote their learning and growth in practice. Therefore, to better radiate their educational energy in the future kindergarten education, college preschool education majors should actively explore the implementation of the nature education program, master the educational teaching methods, and be able to combine with the actual learning situation of young children to build a highly efficient learning environment, which will help young children's sustainable and comprehensive development.

2. Teaching values of kindergarten nature education courses for preschool education majors in colleges and universities

2.1. Cultivating young children's innovative thinking

The growth of everything in nature has infinite mysteries and possibilities, guiding young children to approach, observe, and explore nature can effectively stimulate their curiosity, prompting them to experience the magic and mystery of nature. This process of exploring the unknown is the process of sprouting innovative thinking. In this process, creative nature education activities can be designed to effectively guide young children to discover, analyze, and solve problems, which can effectively promote the development of young children's innovative thinking ^[1].

2.2. Enhancing young children's practical skills

The kindergarten nature course is a practical course that requires children to learn knowledge through hands-on experience and operation, which is more likely to enhance children's motivation and enthusiasm for learning than simple classroom lectures. Given this, in practical education, we can actively organize practical nature education courses for young children to operate and explore independently, which not only enables young children to learn relevant scientific knowledge but also improves their practical hands-on and operational skills, providing a solid guarantee for their sustainable development.

2.3. Cultivating young children's awareness of environmental protection

In the implementation of kindergarten nature education courses for preschool education majors in colleges and universities, young children will come into contact with a lot of knowledge about ecological protection and sustainable development, recognize the impact of human activities on the environment, and then give them effective guidance, which can promote young children to generate a sense of responsibility for protecting the environment and caring for nature from childhood ^[2]. At this time, some meaningful nature education activities can be organized to allow young children to experience the importance of environmental protection in practice and form good environmental habits.

3. Teaching strategies of kindergarten nature education programs for preschool education majors in colleges and universities

3.1. Allowing young children to get close to nature and feel its beauty

To effectively carry out the nature education program in kindergarten education, college preschool education majors should lead young children to get close to nature and feel the beauty of nature. Specifically, the educational practice, should grasp the "six-one" teaching methods, respectively, look, listen, taste, smell, talk, and play, through the vision, taste, hearing, smell, and other multi-sensory, as well as physical movement, to understand the charm of nature. This is an important way to promote the implementation of the nature education program in kindergartens, effectively helping young children explore and experience nature ^[3].

For example, based on the theme of "close to nature, feel beautiful," we can design a "park exploration" nature program, but it must be carried out under the premise of ensuring the safety of young children and following the "six-one" strategy. First, we can organize visits to nearby nature parks and let young children carefully observe the form of trees, the color texture of leaves, the activities of small animals, as well as small rivers, etc. Through the observation of the nature of grass, trees, animals, and water, children can discover the diversity of the natural world and the miracle of life, and effectively cultivate their power of observation and

thinking. Secondly, a quiet open space in the park can be chosen for children to sit on the ground, close their eyes, listen carefully, and perceive the surrounding sounds, such as the rustling sound of the wind blowing through the treetops, the birds' twittering sound, etc. In this process, children can feel the rhythm and rhyme of nature with their hearts, and strengthen their auditory perception and emotional experience ability ^[4]. Subsequently, under the condition of ensuring safety and sufficient washing, children are to taste the fruits of nature, and knowledge of fruit cultivation and growth can be shared for them to fully understand the relationship between food and nature. Next is the element of smell. The smell is one of the most primitive human senses and can evoke deep emotional memories. In the implementation of kindergarten nature curriculum, children can be guided to smell the aroma of different plants, such as the freshness of trees and the fragrance of flowers, to have a deeper feeling of the charm of nature and exercise their olfactory sensitivity in their olfactory experience. After experiencing a series of sensory experiences, children can be encouraged to express their feelings and thoughts about visiting the park, such as sharing what they think is the most interesting thing or describing their favorite natural scenes, which will enhance children's linguistic expression and improve their understanding and love of nature through tender language communication. Finally, interesting nature course game activities can be organized, such as letting children collect natural objects in the park to complete a nature puzzle together so that children can learn and understand nature knowledge in a pleasant atmosphere and exercise their fine workability. Letting children get close to nature and feel the beauty of nature in the nature course can promote their overall development in many aspects ^[5].

3.2. Allowing children to explore nature and promote in-depth learning

In the development of a kindergarten nature education program, letting young children close to nature is only the first step of teaching, we need to pay more attention to letting young children learn more natural knowledge, enrich their inner culture, expand their knowledge of boundaries to establish a comprehensive cognition to lay a solid foundation. At this time, college preschool education students can lead young children to explore nature in educational practice. Combined with traditional festivals, targeted nature education thematic exploration activities can be conducted, which are designed for them to progressively explore the task of leading young children to learn while building cognition, achieve the desired educational goals, and better prepare for the work of preschool education ^[6].

For example, taking the nature education program of "Qingming Festival" as an example, Qingming Festival is not only a natural festival but also a traditional festival in China, and its main customs include tomb-sweeping and ancestor worship, as well as activities like hiking, kite flying, and more. In practice, preschool students in higher education can seize this educational opportunity to organize diversified nature education theme activities, so that young children's deep learning is promoted in the process of exploring nature. In teaching, the topic of festivals can be introduced first; with the help of advanced technical equipment, the cultural significance of the Qingming Festival and some major customs are shown to young children, so that they can build up the cognition that Qingming Festival is one of the traditional festivals in China, which is not only a time to remember the ancestors, but also a good time for spring excursions and hiking, and the presentation of pictures and language explanation helps them understand the cultural connotations of the Qingming Festival. Next, teachers can present children with relevant picture books, such as *Grandma's Green Dumplings*, which tells the process of making green dumplings. In the practice of the nature education curriculum, leading children to observe the illustrations and read the simple text depictions not only enables them to learn about the Qingming Festival but also stimulates their curiosity about nature, which is another

important way for them to learn about the world. After that, children can be led to explore plants. Spring is the season when the natural world is most vigorous, so they can go out of the classroom to observe the growth of plants inside and outside the campus, and record which plants have begun to germinate, which flowers have blossomed, as well as their colors, shapes, and growth rates, to cultivate children's powers of observation and memory, and to let them experience the miracle of life and growth firsthand. Finally, meaningful nature exploration activities can be carried out, such as hiking. Under the guidance of the teacher, children can run and play in the natural environment, breathe fresh air, and enjoy the beauty of spring. They can also make kites together and fly them in an open space outdoors to exercise their hands-on skills and let them feel the power and direction of the wind. This kind of learning method, which centers on the theme of festivals and leads children to explore nature, allows them to learn and experience traditional Chinese culture and develop observation, thinking, and creativity in the process of getting close to nature, thus facilitating the occurrence of in-depth learning in young children^[7].

3.3. Allowing young children to respect nature and realize the spirit of harmonious coexistence

As a part of the natural world, human beings have the ability to create and build nature based on following the laws of nature. However, no matter how much time has passed and how advanced technology is, it is impossible to completely detach ourselves from the embrace of nature. It can be said that carrying out nature education programs in kindergartens is crucial to the sustainable development of young children, which can not only prompt young children to establish the awareness of respecting and protecting nature from childhood, but also cultivate their ability to care for plants and animals. Given this, when constructing the teaching of nature education courses, preschool education majors in colleges and universities should not only let young children get close to and explore nature, but also let them establish the consciousness of respecting nature, comprehend the spirit of living in harmony with nature, and understand that only through the protection of the natural environment can the sustainable development of human beings be ensured.

First of all, we need to follow the discovery of young children and do a good job of life education. Influenced by the age factor, young children have a strong sense of curiosity and are full of desire to explore everything around them. In the development of nature education programs, teachers should grasp the opportunity for education to carry out appropriate life education. For example, children can grow plants themselves, carry out activities such as "planting cucumbers" and "planting tomatoes," and encourage them to actively participate in plant cultivation, loosening the soil, watering the plants, and experiencing the miracle of life. In the process of children's participation, some plants were affected by a variety of factors and did not survive, leading to some children feeling unhappy and discouraged. In the face of this situation, teachers can follow the children's perception to carry out life education and lead the children to watch some videos or read some picture books, so that the children feel the power of life and produce a sense of awe of nature. Secondly, we need to take care of the environment. Environmental protection is not only a slogan, but also needs active efforts. The nature of a flower and a tree are symbols of life, based on this, teachers can teach simple daily education behavior, such as educating young children to not pick flowers or destroy the plants, but should respect their growth rules, to achieve a harmonious symbiosis of man and nature. Students of preschool education in higher education can set an example for young children when they enter kindergarten work in the future by contributing to the protection of the Earth.

3.4. Allowing children to express nature and show the secrets of nature

Being in a fast-paced modern society, young children have less and less intimate contact with nature, and their understanding and experience of nature are more limited to textbooks or videos. As an important starting point for the growth and development of young children, kindergartens bear the responsibility of guiding young children to explore nature and feel the beauty of nature. Therefore, when preschool education majors in colleges and universities engage in kindergarten work in the future, they should provide more opportunities for young children to enter nature, and join hands with parents, so that young children, accompanied by parents, can express their perceptions of nature more freely, and unveil the secrets of nature together ^[8].

For example, in the teaching of nature education curriculum, a special spring excursion can be designed to encourage parents to put down their cell phones, turn off their electronic devices, and devote themselves to interacting with their children. Young children and their parents can enter nature on weekends, experience and discover nature, and display these precious experiences in a piece of artwork full of childlike innocence and creativity. In the natural environment, parents can let their toddlers run wild and accompany themselves, guiding them to feel and think. Returning home, children can express what they see and feel by painting, using watercolors to depict colorful flowers, or using colored paper to collage lifelike animals, creating a unique interpretation of the beauty of nature. Parents can guide their children when they need help, otherwise, they can quietly admire their children's creative process and enjoy their ability to express the beauty of nature. After that, children can be allowed to bring their works to the class for display and share the secrets of nature in their paintings, effectively colliding learning thinking, so that children learn in happiness and grow in learning.

4. Conclusion

In conclusion, students majoring in preschool education in colleges and universities, when implementing kindergarten nature education courses, should synthesize the actual situation of kindergartens and adopt diversified teaching strategies to promote the effective development of nature education courses. In practical education, young children can be prompted to learn to live in harmony with nature and effectively enrich their learning experience by allowing them to get close to nature, explore, revere, and express nature.

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New Opportunities, Challenges, and Strategies for Educational Evaluation Reform in the Era of Artificial Intelligence

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Abstract: Under the rapid impetus of artificial intelligence (AI) technology, human society is stepping into the age of intelligence at an unprecedented speed. A new generation of information technology such as AI is not only a new engine of economic development, but also a gas pedal of social development, which has had a profound impact on the field of education. In the face of the opportunities and challenges of the AI era, it is particularly urgent to build a scientific and reasonable education evaluation system. This paper combines the context of the times with the new technology of AI to discuss the opportunities, challenges, and implementation strategies of educational evaluation reform in the era of AI, with a view to providing references for the construction of the educational evaluation system and the development of high-quality education in the new era.

Keywords: Artificial intelligence; Education evaluation reform; New policy; Formative evaluation; Value-added evaluation; Multiple evaluation

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1. Introduction

Driven by the wave of artificial intelligence, the field of education is experiencing unprecedented changes. From educational philosophy to talent cultivation goals, from educational content to educational resources and environment, and to educational methods and talent cultivation methods, each link deeply reflects the impact of intelligence. Educational evaluation, as a key link in navigating the course of education, must keep pace with the times and adapt to the needs of the new era. In the face of the opportunities and challenges of the artificial intelligence era, it is particularly urgent to build a scientific and reasonable education evaluation system. In October 2020, the Overall Program for Deepening the Reform of Educational Evaluation in the New Era (hereinafter referred to as the “Overall Program”) issued by the Central Committee of the Communist Party of China (CPC) and the State Council, explicitly proposes that we should make full use of information technology

to improve the scientific, professional, and objective nature of educational evaluation ^[1], encouraging and supporting the intelligence and innovation of evaluation tools, means and methods. This requires us not only to make full use of the new generation of information technology such as artificial intelligence to optimize the evaluation means and enrich the evaluation content, but also to ensure the fairness of the evaluation process and the effectiveness of the results, so as to guide education in the direction of a more personalized, comprehensive, and quality-oriented development. This is not only an important issue in the current education reform, but also a necessary way to realize the high-quality development of education.

2. Opportunities for artificial intelligence-driven educational evaluation reforms

2.1. The enabling role of artificial intelligence technology: Reshaping the precision and efficiency of educational evaluation

The rapid development of artificial intelligence technology, especially the breakthroughs in cutting-edge fields such as big data analysis, machine learning, natural language processing, etc., has brought revolutionary changes to the field of education evaluation. These technologies not only make it possible to collect, process, and analyze huge amounts of educational data, but also realize real-time monitoring and in-depth insight into students' learning behavior, cognitive development, and even psychological changes. By building an intelligent education evaluation system, teachers can grasp the learning dynamics of students in real time, identify problems in a timely manner, and provide personalized feedback and suggestions, effectively improving the accuracy and timeliness of education evaluation.

In addition, artificial intelligence can intelligently push learning resources that meet the needs of students based on their historical learning data and current learning status, realizing the personalized customization of learning paths. This intelligent push mechanism not only meets the personalized learning needs of students, but also promotes the optimal allocation and efficient use of educational resources. Empowered by artificial intelligence technology, education evaluation is no longer just a summation, but a dynamic assessment and guidance throughout the entire learning process, providing strong support for the comprehensive development of each student.

2.2. A profound shift in educational philosophy: From knowledge transfer to core literacy development

The popularization and application of artificial intelligence technology have profoundly affected the reshaping of the concept of education. Traditionally, education focuses on the transmission and accumulation of knowledge, but in the era of artificial intelligence, this concept is gradually shifting to the cultivation of core literacy. Core literacy includes independent learning ability, critical thinking skills, innovation ability, and interpersonal communication skills, which are crucial for students' survival and development in the future society. Educational evaluation, as an important means of testing the effectiveness of education, must keep up with the shift in educational philosophy, expanding from single knowledge evaluation to comprehensive quality evaluation.

Through the support of artificial intelligence technology, educational evaluation can more comprehensively and objectively assess the development of students' core literacy. For example, analyzing students' homework and discussion records using natural language processing technology can assess their critical thinking and expression skills; monitoring students' online learning behavior through data analysis technology can shed light on their independent learning ability and time management skills. This multi-dimensional and all-encompassing

assessment helps to more accurately grasp students' individual differences and developmental needs, providing a more scientific basis for tailoring teaching to students' needs.

2.3. Guidance and support of new policies: Escorting the reform of education evaluation

The introduction of the Overall Program provides clear policy guidance and support for education evaluation reform in the new era. The program emphasizes making full use of information technology means to improve the scientific, professional, and objective nature of education evaluation, and encourages and supports the intelligence and innovation of evaluation tools, means, and methods. This policy background provides a broad development space and policy guarantee for the application of artificial intelligence technology in education evaluation.

Led by the policy, local education departments have increased investment to promote the intelligent upgrade of the education evaluation system. On the one hand, the research and development and application promotion of artificial intelligence technology have been strengthened to enhance the technical content and intelligent level of education evaluation; on the other hand, the relevant policies, regulations, and standard systems have been improved to guarantee the safe, reliable, and effective application of artificial intelligence technology in education evaluation. These initiatives provide a solid institutional guarantee and a favorable development environment for artificial intelligence-driven education evaluation reform.

To summarize, the enabling role of artificial intelligence technology, the profound transformation of educational concepts, and the guidance and support of new policies together constitute three major opportunities for artificial intelligence-driven education evaluation reform. Seizing these opportunities and actively promoting the intelligent upgrading and innovative development of the education evaluation system is of great significance for improving the quality of education and promoting the overall development of students.

3. Challenges to educational evaluation in the age of artificial intelligence

In the current education system, the evaluation method still mainly relies on standardized quantitative evaluation, which is easy to operate and compare, but its limitations are also becoming more and more prominent. Quantitative evaluation overemphasizes test scores, often taking scores as the only or main criterion for measuring students' strengths and weaknesses, thus ignoring students' performance in non-cognitive areas such as moral character, emotional attitude, innovative spirit, practical ability, and so on. This type of evaluation is particularly inadequate in the age of artificial intelligence because it cannot comprehensively and accurately reflect students' comprehensive qualities and abilities.

The introduction of artificial intelligence technology provides the possibility of constructing a diversified and multidimensional evaluation system. Through the comprehensive use of qualitative and quantitative evaluation, combined with big data analysis, machine learning, and other advanced technological means, it is possible to gain a more comprehensive and in-depth understanding of students' learning status, interest preferences, abilities, and specialties, and then form a more scientific and reasonable evaluation conclusion. However, to achieve this goal, it is still necessary for educators and researchers to continue exploring and innovating and to develop a new type of evaluation that is more in line with the needs of the times.

3.1. Traditional and outdated means of evaluation: Limiting the efficiency and depth of evaluation

Despite the rapid progress of science and technology, the means of educational evaluation are still relatively traditional and backward. In many regions and schools, educational evaluation still relies mainly on the

traditional paper-and-pencil test and manual grading. This method is not only inefficient but also susceptible to the influence of human factors, which makes it difficult to ensure the objectivity and accuracy of evaluation results. The introduction of artificial intelligence technology provides strong support for the intelligent upgrading of educational evaluation tools. Through the development of intelligent evaluation tools and systems, real-time monitoring and data analysis of the students' learning process can be realized to improve the efficiency and accuracy of evaluation ^[2]. At the same time, intelligent evaluation tools can also automatically adjust evaluation strategies and standards according to students' learning behaviors and characteristics to achieve more personalized and precise evaluation. However, to realize this goal, it is necessary to overcome the challenges of technology, funding, talent, and other aspects.

3.2. One-sidedness of evaluation content: Neglecting the assessment of non-cognitive domains

The current content of educational evaluation mostly focuses on the mastery of subject knowledge and skills, while the assessment of non-cognitive areas such as students' emotions, attitudes, and values is relatively insufficient. This one-sidedness of evaluation content not only limits the ability to assess students' overall development but also affects the realization of educational goals. In the era of artificial intelligence, the content of educational assessment needs to be more comprehensive and diversified. In addition to the assessment of disciplinary knowledge and skills, the assessment of non-cognitive domains such as core literacy, innovation ability, teamwork ability, etc. should also be incorporated into the evaluation system. Through the comprehensive use of a variety of evaluation methods and tools, students' comprehensive quality and ability should be comprehensively assessed, so as to provide a more scientific basis for teaching students according to their aptitude. At the same time, it is also necessary to strengthen the assessment of students' learning processes and methods and pay attention to their performance in terms of learning attitudes, methods, and strategies.

3.3. The unitary nature of evaluation standards: Difficult to adapt to the needs of individualized development

Existing education evaluation standards are often based on scores or promotion rates, and this single evaluation standard is difficult to fully reflect students' individual differences and potential. In the era of artificial intelligence, with the diversified development of social demand for talent, the single evaluation standard can no longer meet the needs of personalized education. In order to meet the needs of personalized education, a multi-dimensional evaluation standard system needs to be established. This includes focusing on the application of process evaluation and value-added evaluation to comprehensively assess students' growth progress and development potential. It is also necessary to develop differentiated evaluation standards and methods according to the characteristics of different school years, subjects, and students, so as to achieve the goals of tailor-made education and personalized evaluation. In addition, there is a need to strengthen the publicity and promotion of the assessment standards and raise awareness and acceptance of the multidimensional assessment standards among all sectors of society.

3.4. Limitations of evaluation subjects: Lack of multi-party participation and synergy

The current subject of education evaluation is relatively narrow, mainly teachers and students, lacking the participation of parents, society, and other parties. This limitation affects the objectivity and fairness of evaluation to a certain extent and is not conducive to the formation of educational synergy. In the era of artificial intelligence, it is necessary to build an evaluation system in which multiple evaluation subjects participate

together. This includes strengthening the participation and voice of parents, communities, enterprises, and other social sectors in education evaluation, and forming a synergy in education evaluation. The transparency and credibility of education evaluation should be enhanced through the introduction of a third-party evaluation mechanism and a social supervision mechanism, among other means. At the same time, it is also necessary to strengthen the cultivation and guidance of students' self-evaluation ability, encourage students to actively participate in activities such as self-evaluation and peer evaluation, and improve their sense of subjectivity and self-reflection ability. The implementation of these measures can promote the development of educational evaluation in the direction of greater democratization, scientification, and humanization.

4. Strategies for using artificial intelligence to help educational evaluation system innovation

4.1. Promoting the diversification of evaluation methods to achieve comprehensive evaluation

In the era of artificial intelligence, the traditional single, standardized quantitative evaluation method has been difficult to meet the evaluation needs of students' comprehensive quality. Therefore, promoting the diversification of evaluation methods and realizing the organic combination of process evaluation, formative evaluation, and summative evaluation have become an important direction of educational evaluation reform. By introducing artificial intelligence technology, an intelligent evaluation system can be constructed to monitor students' learning processes and behavioral data in real time. Such a system can record every attempt and interaction of students in the learning process, thus comprehensively reflecting students' learning attitudes, methods, effectiveness, and other dimensions. For example, analyzing students' classroom discussion records using natural language processing technology can assess their critical thinking and oral expression abilities; tracking students' learning paths and interaction behaviors on online platforms through data analysis technology can understand their independent learning abilities and problem-solving strategies^[3]. This diversified evaluation method can reveal students' comprehensive quality and ability level more comprehensively and provide richer information support for educational decision-making.

4.2. Developing intelligent evaluation tools to improve evaluation efficiency and accuracy

With the rapid development of big data, cloud computing, and other technologies, the development of intelligent evaluation tools has become an important way to improve the efficiency and accuracy of educational evaluation. These tools can automate a large amount of repetitive work and reduce the burden on teachers, while improving the objectivity and scientificity of evaluation. Specifically, an intelligent paper marking system can be developed, which utilizes technologies such as image recognition and natural language processing to quickly and accurately complete the correction of test papers and improve the efficiency of paper marking. At the same time, a learning situation analysis system can be developed to monitor students' learning status and progress in real time and provide teachers with timely teaching feedback. In addition, an intelligent push system can be developed to recommend personalized learning resources for students according to their learning needs and progress, so as to realize tailor-made teaching. The application of these intelligent assessment tools can not only improve assessment efficiency but also provide students with more personalized learning support.

4.3. Expanding evaluation content and focusing on comprehensive quality evaluation

In the era of artificial intelligence, educational evaluation should focus on the comprehensive evaluation of

students' comprehensive quality. In addition to traditional subject knowledge and skills, non-cognitive factors such as students' emotions, attitudes, and values should be included in the evaluation system. These non-cognitive factors have an important impact on students' lifelong development and social adaptability. The use of artificial intelligence technology to collect and analyze students' multidimensional data, such as learning behavior data, psychological characteristics data, social interaction data, etc., can provide a scientific basis for comprehensive quality evaluation^[4]. For example, by analyzing students' learning behavior data, we can understand their learning attitude, self-discipline, and time management ability; through the analysis of psychological characteristics data, we can assess their psychological quality such as emotional stability and stress resistance; through the analysis of social interaction data, we can evaluate their social literacy such as teamwork ability, communication skills, and leadership. The comprehensive analysis of these data can reflect the comprehensive quality and ability level of students.

4.4. Establishing multi-dimensional evaluation standards and focusing on process evaluation and value-added evaluation

The construction of a multi-dimensional evaluation standard system is one of the keys to education evaluation reform. In the era of artificial intelligence, more attention should be paid to process evaluation and value-added evaluation in order to comprehensively and objectively assess students' growth and development. Process evaluation focuses on students' performance and efforts in the learning process, and evaluates their learning attitudes, methods, and effectiveness by recording and analyzing every attempt and every bit of progress in the learning process. This type of assessment helps teachers identify problems, adjust teaching strategies, and provide students with personalized learning suggestions. Value-added assessment focuses on assessing students' growth and progress over a period of time and evaluating their development potential and effectiveness by comparing the changes in their initial and final states. This type of assessment helps encourage students to actively participate in the learning process and personalize their development.

The use of artificial intelligence technology to track students' learning progress and development trajectory enables the precise implementation of process and value-added evaluation. For example, by constructing a student growth file system, every attempt, progress, and feedback of students in the learning process is recorded, forming a complete map of students' development trajectory. At the same time, using data analysis technology to conduct in-depth mining and analysis of students' growth trajectory, we can find out students' growth patterns and development bottlenecks, providing a scientific basis for educational decision-making.

4.5. Promoting the diversification of evaluation subjects and forming a multi-party joint evaluation mechanism

In the era of artificial intelligence, educational evaluation should encourage the participation of parents, communities, third-party organizations, and other parties in the evaluation system. This multi-party co-evaluation mechanism can help improve the objectivity and fairness of evaluation and promote the democratization and scientization of educational evaluation. The sharing and exchange of evaluation information through artificial intelligence technology can break the limitations of closed information and one-way transmission in traditional evaluation. For example, a home-school co-education platform can be constructed to allow parents to learn about students' performance and learning progress at school in real time; a community education evaluation system can be developed to allow community members to participate in evaluating students' social practices and volunteer services, etc.; and third-party organizations can be introduced

to carry out independent evaluations to ensure that the results of the evaluations are objective and fair. The implementation of these measures will help to form an open, inclusive, and pluralistic education evaluation ecosystem^[5].

At the same time, attention should be paid to cultivating students' self-evaluation ability. By guiding students to use intelligent evaluation tools for self-reflection and self-evaluation, their self-knowledge and self-improvement can be promoted. For example, a student self-reflection system can be developed to allow students to summarize and reflect on themselves after completing learning tasks; a peer evaluation mechanism can be introduced to allow students to discover their strengths and weaknesses in mutual evaluation. The implementation of these measures will help to develop students' independent learning ability and lifelong learning ability.

5. Conclusion and prospects

The arrival of the era of artificial intelligence provides unprecedented opportunities and challenges for the reform and innovation of the educational evaluation system. With the rapid development of the new generation of information technology, educational evaluation is no longer limited to the traditional standardized quantitative evaluation, but is gradually moving towards diversification, intelligence, and comprehensiveness. By making full use of advanced technologies such as big data, cloud computing, and artificial intelligence, the education evaluation system can more objectively and scientifically reflect students' comprehensive quality and ability. Under the guidance of the Overall Program for Deepening the Reform of Educational Evaluation in the New Era, we need to actively promote the diversification of evaluation methods, focusing not only on outcome evaluation, but also on process evaluation and qualitative evaluation. Through intelligent evaluation systems, we can monitor students' learning process in real time and collect and analyze a large amount of behavioral data, so as to achieve more accurate and personalized evaluation. At the same time, the development of intelligent evaluation tools is also an important direction of educational evaluation innovation. Taking advantage of artificial intelligence technology, more efficient and accurate evaluation tools can be developed to reduce the burden on teachers and improve the efficiency of evaluation. These tools can not only help teachers teach accurately but also provide personalized learning suggestions for students and promote their overall development. In addition, expanding the content of evaluation, establishing multi-dimensional evaluation standards, and promoting the diversification of evaluation subjects are also critical tasks in education evaluation reform. We need to pay attention to the all-round development of students, evaluating not only their mastery of knowledge but also their non-cognitive abilities such as thinking ability, innovation, and teamwork. At the same time, students, parents, teachers, and the community are encouraged to participate in the evaluation process, forming a pluralistic and co-governance education evaluation system.

Looking ahead, with the continuous development and application of artificial intelligence technology, the education evaluation system will be continuously improved and optimized. By building an educational evaluation system that meets the requirements of the new era, we can better cultivate high-quality talents with innovative spirit and practical skills, and provide strong talent support for the country's economic and social development. We believe that with the help of artificial intelligence technology, the education evaluation system will usher in a better tomorrow.

Disclosure statement

The authors declare no conflict of interest.

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A Study on the Cross-Cultural Communication of Chinese Opera Cultural Elements in Teaching Materials of Chinese as a Foreign Language: Taking *New Practical Chinese Readers* as an Example

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Abstract: This paper selects the widely used *New Practical Chinese Readers*, a comprehensive teaching material for Chinese as a foreign language, analyzing its content selection, presentation format, and organizational characteristics. By reviewing the inclusion of Chinese opera cultural elements in this material, the study identifies existing issues and provides recommendations for improvement. Introducing opera culture into Chinese language teaching materials can align with global cultural exchanges, helping more people learn about traditional Chinese culture and enhancing China's international influence.

Keywords: Chinese opera cultural elements; Teaching materials; Chinese as a foreign language; Cross-cultural communication

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1. Introduction

In the Report to the 20th National Congress of the CPC, General Secretary Xi Jinping put forward the task of “extending the reach and appeal of Chinese civilization” while “telling China’s story well and making China’s voice heard.” Language and culture are closely linked, and teaching Chinese as a foreign language is both language teaching and cultural communication. Both classroom teaching and compiling teaching materials should incorporate traditional Chinese cultural elements. With the proposal of the Belt and Road Initiative, the cross-cultural communication of Chinese operas has become an important way to promote China’s cultural diplomacy, which is helpful to highlight the “Silk Road Spirit” and forge closer bonds between peoples^[1].

As Chinese learners with different cultural backgrounds, the integration of opera culture in their textbooks

enables students to master the Chinese language as well as understand the excellent traditional Chinese culture. However, there are several issues with the inclusion of opera culture elements in current teaching materials, such as the lack of a systematic introduction to opera culture and its diverse genres, with most content remaining at the conceptual level.

Based on this, this paper takes the *New Practical Chinese Readers* as a case study to investigate the similarities and differences in the content selection, presentation, and arrangement of the opera cultural elements. It also sorts out the problems existing in the textbook compilation and finally offers some targeted suggestions.

2. Research status

Yang ^[2] mainly studied the compilation of cultural factors in the comprehensive primary Chinese textbooks. Taking *New Practical Chinese Readers* and *Developing Chinese* as examples, it reveals the similarities and differences between the two different primary Chinese textbooks and provides targeted suggestions ^[2]. Zhang identified issues related to the inclusion of Chinese opera in textbooks and classroom teaching, proposing improvement strategies based on these findings ^[3]. Zong explored the application of China's intangible cultural heritage in teaching Chinese as a foreign language (TCFL), which mainly designed the calligraphy class and paper-cutting class, and offered suggestions for classroom teaching and textbook compilation respectively ^[4]. Qian examined the application of Huangmei Opera in cultural courses of international Chinese education, analyzing its strengths, weaknesses, opportunities, and threats in entering TCFL cultural classrooms ^[5]. Ke and Yan, through the investigation of opera cultural elements in 110 Chinese textbooks, argued for strengthening the dissemination of opera culture, drawing on existing experiences, and incorporating it into textbooks to raise learners' awareness of its significance ^[6]. Sun investigated the intangible cultural heritage factors in cultural textbooks for TCFL and proposed three recommendations for better utilizing such elements ^[7]. Jin selected *Happy Chinese* and *Easy Steps to Chinese* as the research objects to compare the number, types, and presentation forms of cultural points in the two textbooks to explore the arrangement of cultural points in the textbooks ^[8]. Yang analyzed cultural factors in *Learn Chinese through Music*, categorizing these elements into three levels (primary, secondary, and tertiary) and studying their arrangement to provide suggestions for textbook revisions ^[9]. Sun took *Developing Chinese* as the research object and made a three-dimensional analysis according to social life, traditional culture, and contemporary China ^[10].

To sum up, while there has been considerable research on incorporating cultural or intangible heritage elements into Chinese teaching, studies focusing specifically on Chinese opera in teaching materials remain limited. Moreover, most research emphasizes classroom teaching, with less attention paid to textbook content development.

3. Importance of applying Chinese opera cultural elements to teaching materials of Chinese as a foreign language

Language learning is inseparable from cultural integration, and teaching Chinese as a foreign language is also inseparable from cultural teaching. The two are interrelated and interdependent. Traditional Chinese opera bears thousands of years of history and profound artistic connotations. Therefore, foreign students can learn about ancient values and aesthetic concepts through the introduction of traditional Chinese opera culture in the textbooks, which helps Chinese opera go global.

3.1. Helping international students understand traditional Chinese values

Most of the stories told by traditional operas are based on honesty and justice. Meanwhile, foreign students can learn about the Confucian concept of Five Constants by studying opera culture, fully realizing Chinese values and promoting mutual understanding.

3.2. Helping international students improve their language skills

Chinese opera contains a large number of idioms and technical terms, such as “make oneself up and go on the stage,” “singing, reciting, acting, and fighting,” “long-sleeved style,” “Liyuan aristocratic family,” “costumes and props,” “beat pattern,” “strike a pose,” “challenging someone,” and so on. Therefore, the historical stories of these words can be presented to students when designing the teaching materials, so that they can fully understand and use them flexibly in communication, thus improving their language skills.

3.3. Enhancing the interest of the classroom

The unique features of Chinese opera, distinct from Western drama, captivate learners with its novelty. Integrating opera culture into textbooks can make lessons more attractive and spark students’ interest in learning Chinese.

3.4. Promoting the popularization of Chinese opera

The education of Chinese opera is the key to passing down the art as well as an important carrier for conveying Chinese ideas and values. Introducing Chinese opera elements into teaching materials will help more foreign students understand Chinese opera and enhance its influence and popularity.

4. Rationale for selecting the New Practical Chinese Readers

The *New Practical Chinese Readers*, influenced by the late 1990s “structure-function-culture” approach, is widely used and caters to a broad audience. Comprising four volumes and 50 lessons, it builds on the Practical Chinese Reader and overseas teaching experience. It is primarily designed for Chinese learners whose native or primary language is English.

5. Statistics and analysis of opera cultural elements in New Practical Chinese Readers

5.1. Content selection

5.1.1. Opera genres

China’s national opera boasts a long history with 275 recorded forms. In the textbook, Peking Opera and Yue Opera are mainly introduced, with Peking Opera mentioned 20 times. Yue Opera mainly appeared in lesson 22 and was referenced as an example seven times in other lessons.

5.1.2. Opera costumes

Costumes serve as a crucial tool in shaping characters, bridging the gap between actors and their roles. In lesson 6, three pictures are shown, through which students can observe the facial makeup, beard pieces, and headdresses worn by actors, but there is no detailed explanation of their types and characteristics.

5.1.3. Opera roles

The role of traditional Chinese opera is divided into five categories according to gender and role characteristics: Sheng, Dan, Jing, Mo, and Chou. In the whole textbook, there is an introduction about the roles of Jia Baoyu and Lin Daiyu in *Dream of the Red Chamber* and the characters in the opera *Butterfly Lovers*.

5.1.4. Opera movements

Actions in opera are essential for conveying a character's personality and emotions. In lesson 6, it is briefly mentioned that suggestive movements in opera are performed in coordination with the melody of traditional musical instruments. However, the lesson fails to provide foreign students with a deeper understanding of the martial arts techniques and dance skills.

5.1.5. Opera performance artists

Opera artist refers to an artist who is engaged in the creation of opera art and has made outstanding achievements in this field. Lanfang Mei, a famous Chinese performing artist, was mentioned in lesson 6, but his life, outstanding achievements, and influence on Chinese opera were not mentioned too much.

5.1.6. Opera works and theaters

Lesson 6 mentioned the work *Farewell My Concubine*, and encouraged students to go to Mei Lanfang Theater, Chang'an Theater, and other theaters to watch this work. Lesson 15 mentioned the opera *Butterfly Lovers*, and lesson 22 mentioned *Dream of the Red Chamber* at Chang'an Theater.

5.2. Forms of content presentation

5.2.1. Text form

The *New Practical Chinese Readers* primarily introduces Peking Opera and Yue Opera to foreign students through textual content. The discussion of traditional Chinese opera is mainly concentrated in lessons 6 and 22, while references in other lessons appear in the form of related topics.

5.2.2. Form of vocabulary

Most new words are presented within texts and vocabulary lists, with some extended for additional context. However, relying on individual words or phrases to convey opera culture makes it challenging for learners to gain a clear understanding, offering only a basic introduction.

5.2.3. Example form

The author found that "Peking Opera" is used as a sentence-making vocabulary when explaining grammar in most courses. By making sentences, students can master language and grammar rules, thereby improving their language application ability. The repetition of Peking Opera and Yue Opera helps consolidate students' knowledge of opera.

5.2.4. Annotation form

After-class notes in lesson 6 introduce Peking Opera in English, while lesson 22 covers the style and regional distribution of Yue Opera, helping students expand their knowledge and deepen their understanding of each opera's roots.

5.2.5. Practice form

The author found that opera content mainly appears in the practice section as “familiar phrases,” “sentence pattern replacement,” and “conversation practice.” Incorporating opera into these practices helps deepen foreign students’ impression of opera, while after-class reading further enhances their interest in learning Chinese.

5.2.6. Writing form of Chinese characters

Lesson 22 introduces in detail the stroke order of the character “Yue (越),” the historical origin of the character “Yue (越),” and the stroke order of “Xi (戏).” Understanding the origin and stroke order of Chinese characters is helpful for foreign students to understand and use Chinese characters, as well as to feel the long history of Chinese civilization.

5.3. Characteristics of content distribution and arrangement

In terms of content distribution, the appearance of opera cultural elements is uneven. It appears very often in lesson 6 and lesson 22, while in the other texts, only opera genres are shown as example sentences. The two phrases “Peking Opera” and “Yue Opera” have a high repetition rate in texts and after-class exercises, which is conducive to the consolidation of knowledge.

In terms of content arrangement, the cultural elements showed a decreasing trend. In the first two volumes of the *New Practical Chinese Readers*, there are more Chinese operas, but the number of appearances in volumes 3 and 4 is not as high as that in volumes 1 and 2.

6. Reflections and suggestions on how to introduce the cultural elements of opera into TCFL textbook

At present, in the textbooks for teaching Chinese as a foreign language, the introduction of traditional Chinese opera cultural elements is too superficial without much narration of its cultural connotation and knowledge background. Besides, the introduction of opera culture lacks systematicity, appearing only as example sentences in each course. The opera types are relatively simple, with Peking Opera and Yue Opera introduced. In view of the above problems, the following improvement suggestions are put forward.

6.1. Increasing the variety of operas and taking into account the diversity of operas

Peking Opera is known as the “national essence” of China. While focusing on Peking Opera, it is also necessary to promote excellent local operas. Incorporating more operas will help international students learn more classical works and famous writers.

6.2. Selecting representative repertoire supplemented by an accurate English translation

When choosing repertoire, representative classical works can be selected. For example, *The Drunken Beauty*, *Butterfly Lovers*, and *Hua Mulan*. In addition, the teaching materials can be accurately translated with the help of the learners’ native language first, and then the Chinese language can be utilized for teaching, which is more conducive to students’ understanding of the content of the opera.

6.3. Selecting opera content close to actual social life

The purpose of teaching Chinese as a foreign language is to cultivate Chinese learners’ ability to communicate in Chinese. Therefore, the content should be selected in accordance with the language norms and for the

service of language communication. For example, words such as “be neither humble nor pushy,” “beat around the bush,” “deliberated,” and so on. It is beneficial to deepen students’ understanding and application of the vocabulary by explaining the connotation of the vocabulary in the opera.

6.4. Adding colorful pictures and classic melodies about opera culture

Through the display of pictures, foreign students can more intuitively feel the charm of Chinese opera costumes and action skills. The display of classical melody, supplemented by the combination of short videos and opera music in the classroom, can immerse students into the cultural atmosphere of Chinese opera in a comprehensive way.

7. Conclusion

In conclusion, as a performing art integrating music, dance, fine arts, and other art forms, Chinese opera is unique in the history of world art. However, it still faces many difficulties in cross-cultural communication. Integrating Chinese opera cultural elements into Chinese language teaching materials for foreigners can be one of the most important ways to promote its foreign dissemination, and this new way of dissemination is conducive to promoting China to the world stage and letting the world listen to China’s voice.

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A Preliminary Study of Multimodal Discourse to Promote the Teaching of Chinese for Specific Purposes

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Abstract: With the increasing global demand for Chinese language, the teaching of Chinese for Specific Purposes (CSP) has occupied an increasingly important position in the teaching of Chinese as a foreign language. However, traditional teaching methods often neglect the role of non-verbal symbols in language comprehension and communication. The multimodal discourse theory provides a new perspective for CSP teaching, which can effectively enhance students' understanding and mastery of specialized terminology and language application skills by integrating multisensory symbol systems such as language, vision, hearing, and touch. This paper starts from the current situation of teaching CSP and analyzes the adaptability between multimodal discourse and CSP teaching, aiming to provide theoretical support and practical suggestions for the innovation of the teaching mode of CSP.

Keywords: Chinese for Specific Purposes; Multimodal; International Chinese language education

Online publication: February 17, 2025

1. Introduction

With the rise of the global Chinese language craze, Chinese for Specific Purposes (CSP) teaching has gradually become an important part of Chinese language teaching. The goal of CSP teaching is to cultivate learners' linguistic competence in specific fields or occupational contexts and to satisfy their professional communication needs. However, the traditional mode of language teaching relies too much on single linguistic symbols without considering non-linguistic symbols and multimodal resources. In today's informatized and digitalized teaching environment, classroom communication presents multimodal discourse characteristics, that is, a mode of communication through the simultaneous participation of multiple senses.

The multimodal discourse theory emphasizes that multiple senses such as auditory, visual, and tactile, and their related symbol systems work together synergistically in the communication. For example, teachers use multiple symbols such as PowerPoint, video, gestures, and facial expressions to help learners understand the teaching content through multimodal input. This kind of teaching method based on multi-sensory stimulation

and multi-symbol systems has unique advantages, especially in CSP teaching. Specific Chinese learners usually need to master the terminology and language application skills of a specific domain. Compared with traditional teaching methods, multimodal discourse can better integrate linguistic and non-linguistic symbols to help students apply what they have learned in real-life scenarios.

Therefore, the purpose of this paper is to explore how multimodal discourse can play a positive role in CSP teaching, promote the improvement of the teaching effect, and provide new ideas for the innovation of specialized teaching modes.

2. Chinese for Specific Purpose

CSP is a concept corresponding to Chinese for General Purpose (CGP), which refers to the Chinese language used in a certain specialized field, a specific scope, and a fixed occasion ^[1]. Du proposed “specific Chinese language teaching,” which is the earliest known conceptual name for CSP ^[2]. Wang formally introduced the term CSP ^[3]. The current understanding of CSP has been developed. With the promotion of the “Belt and Road” initiative and the expanding global influence of China’s economy, there is an increasing demand for composite talents who know both the Chinese language and professional technology. For example, Confucius Institutes in more than 40 countries around the world offer “Chinese+” programs covering up to 10 fields. It shows that the demand for specific Chinese language learning is growing with the deepening of cooperation between China and the rest of the world in various fields.

3. Multimodal theory

In the continuous development of discourse analysis theory, researchers gradually realize that it is no longer possible to analyze and explore discourse comprehensively and thoroughly from the linguistic point of view alone. A considerable part of the meaning of discourse is manifested through non-verbal factors, such as some accompanying language, body language, and non-physical features. Communication is no longer limited to the use of a single sense, and the synergistic discourse of multiple senses has become a trend. The discourse generated under such communication is multimodal discourse ^[4]. Multimodality can provide teaching scenarios and facilitating conditions for foreign language teaching and learning, provide auxiliary conditions for foreign language teaching and learning, and thus improve teaching efficiency; it can provide multi-sensory channels for multimodal discourse communication to express discourse meanings ^[5].

4. Research status

There is a lack of clear specifications of teaching content and assessment standards. Wu proposed that relevant basic theory research and construction should be improved, the application of relevant linguistic theories (e.g., Register theory and Genre theory) and language teaching theories (e.g., demand analysis theory) should be strengthened, and standards and syllabi should be formulated ^[6]. At present, due to the lack of grading for students with different levels of Chinese language proficiency in different majors and a clear hierarchical design of teaching content, there are difficulties for some international students to learn at different stages. Meanwhile, the assessment format mainly focuses on written tests, which assess the theoretical knowledge and basic skills of the language, but fails to adequately assess students’ operational skills, situational application, and group work in a formative manner.

Teaching methods are single, with some common teaching methods in CSP teaching mainly including task-based teaching method, case teaching method, and post-method teaching method ^[7]. Although these methods can support language learning, they often suffer from monotonous content and dull forms due to a lack of focus on specific professional fields. Many current teaching practices rely too heavily on traditional teaching templates without considering the unique needs of each discipline. This limits the effectiveness of CSP teaching, highlighting the need for more personalized and practical adjustments based on disciplinary characteristics.

Research on Chinese for different specialized fields is unbalanced. CSP covers a number of specific fields, however, current research mainly focuses on the fields of Chinese for Medicine and Chinese for Business, especially in terms of relatively mature teaching methods and theoretical systems in language demand analysis, curriculum design, and teaching evaluation. In contrast, research on Chinese language teaching methodology for other fields is still insufficient. Therefore, diversifying and personalizing the development and application of CSP teaching methods in different fields is an important direction in the current research.

5. Integration points between teaching Chinese for Specific Purposes and multimodal teaching

The specialization of language fits with the diversity of multimodal resources. Teaching CSP focuses on language use in specific fields, requiring learners to understand terminology, syntactic structures, and industry language norms. Multimodal teaching enhances this by integrating text, images, audio, and video, offering a richer, more concrete learning experience. This approach helps learners grasp specialized terminology and contexts, facilitating the integration of linguistic and field-specific knowledge. For example, medical Chinese can use anatomy diagrams and video explanations to teach relevant terms in context.

Multimodal teaching can restore authentic language contexts. One of the core objectives of teaching CSP is to cultivate learners to use Chinese effectively and accurately in specific professional contexts and to help them communicate naturally in professional or academic scenarios. This requires learners to understand industry-related terminology, norms of language use in contexts, and sensitivity to the target culture. In this context, multimodal teaching provides a more flexible and realistic teaching experience for CSP with the advantages of diversified symbolic systems and resource integration, so as to enhance learners' motivation and learning performance.

This integration enables intercultural communication and interaction between symbol systems. Teaching CSP is not only about the transmission of language knowledge but also about the cultivation of learners' cross-cultural communicative competence. This is especially important in the context of globalization, where people in different cultures often have large differences in the use of language and symbol systems. Therefore, a key goal in teaching CSP is to enable learners to adapt to multicultural contexts and communicate with people from different cultural backgrounds in a way that allows them to express meaning accurately while following appropriate behavioral and etiquette norms. Multimodal teaching provides rich support for the development of intercultural communicative competence. It enables students to gain a comprehensive understanding of the ways in which language is used and the habits of communication in different cultures by combining verbal and non-verbal symbols (e.g., gestures, facial expressions, body postures, visual symbols, colors, sounds, etc.).

6. Integration of specific Chinese language teaching into multimodal instruction

Designing teaching activities for different specialties: Specific Chinese language teaching can leverage mul-

timodal resources to design activities within specialized contexts for greater authenticity. For example, in a business Chinese classroom, teachers could create a simulated business negotiation activity using videos, PowerPoint, charts, and text materials, encouraging students to engage in role-playing. In an engineering Chinese classroom, teachers could incorporate 3D modeling, drawings, and flowcharts to guide students in presenting a technical proposal, explaining project details and implementation plans.

Using digital platforms for multimodal learning resources: Multimodal resources can be integrated into specific Chinese language teaching through digital platforms like learning management systems or mobile apps. For example, in a medical Chinese course, teachers can provide anatomical diagrams, surgical videos, and audio lectures on an online platform, allowing students to deepen their understanding through diverse symbol systems when reviewing content after class.

Virtual reality and immersive learning: With virtual reality technology, specific Chinese language teaching can offer more immersive learning experiences. Through virtual environments, learners can actively participate in specialized scenarios, such as virtual business meetings or clinics, which enhances learning outcomes.

Establishing a multimodal discourse evaluation system: An evaluation system tailored to multimodal teaching should assess learners' linguistic competence, intercultural communication skills, and practical application abilities in specialized areas. This system should go beyond traditional written tests or single-language assessments to include the use of language, non-verbal symbols (e.g., gestures, facial expressions), and multimodal systems (e.g., images, videos, audio) in cross-cultural contexts. Assessment methods should be diversified, incorporating oral interviews, situational dialogues, and multimodal projects (e.g., product promotions, medical explanations). Students can create presentations using text, images, audio, and video to demonstrate effective integration of these resources for clear, accurate, and persuasive communication in a professional context.

7. Limitations and reflections on the combination of specific Chinese language teaching and multimodal teaching

Information between symbol systems will be overloaded. Multimodal teaching transmits information through multiple symbol systems at the same time, which may lead to information overload, especially when learning a complex specialized language, learners may have difficulty in processing information from multiple sources such as text, images, audio, etc. simultaneously. In this case, the principles of modality selection should be followed, such as the principles of effectiveness, fitness, and economy, to avoid overlap and redundancy in the use of non-complementary modalities^[4].

There is a high dependence on teaching resources. Multimodal teaching often relies on more complex technological resources, such as virtual reality devices, digital platforms, and interactive videos. This makes multimodal teaching a challenge for environments with limited equipment and technology support. In addition, teachers' technological literacy and proficiency may also affect the effectiveness of multimodal teaching, especially teachers without sufficient professional training in traditional teaching and learning may have difficulty in effectively integrating these technological resources.

Teachers may face high demands in designing a complex instructional plan. The design and implementation of multimodal instruction are often much more complex than traditional instruction. Teachers need to spend a lot of time preparing multimodal resources and ensuring that they can be closely integrated with the course content. For example, when designing a legal Chinese course, teachers not only need to provide legal texts but also need to collect and produce appropriate videos, pictures, and other media content, which undoubtedly

increases the workload of teaching preparation. It is doubtful whether the time and resource costs invested can improve the learning effectiveness of learners of specific Chinese.

It may lead to an over-adaptation to the needs of learners. A potential problem with multimodal teaching is over-adaptation to learners' needs, leading to inadequate language proficiency when learners are not supported by multimodal resources. Due to the richness of multimodal resources, learners may become accustomed to comprehending language through a multimodal system and instead find it difficult and stressful to work in real-world scenarios without the support of one or all of the submodalities. Therefore, teachers need to balance the use of multimodal resources with pure language training when designing courses.

8. Conclusion

The combination of Chinese for specific purpose teaching and multimodal teaching has great potential to provide learners with a more authentic, rich, and interactive learning experience, especially in cross-cultural communication and language practice in professional contexts. However, the success of multimodal teaching relies on instructional design, technical support, and the learners' ability. Therefore, it is necessary to balance the use of multimodal resources and traditional teaching methods in practical application to avoid the problems of information overload and over-reliance and to ensure the maximization of teaching effectiveness.

Disclosure statement

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Research on the Reform and Practice of Basic Nursing Teaching Model Based on the OBE Concept

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Abstract: In response to current issues in basic nursing course instruction, this article proposes a teaching model reform based on the OBE (outcome-based education) concept. By resetting course objectives, innovating teaching methods and content, reforming the assessment and evaluation system, as well as conducting practical explorations and case studies, the aim is to enhance teaching quality and cultivate students' practical abilities and comprehensive qualities. The article elaborates on the application of the OBE concept in nursing education and its effectiveness evaluation, providing a valuable reference for nursing education reform.

Keywords: OBE concept; Basic nursing course; Teaching model reform; Practical ability; Comprehensive quality

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1. Introduction

With the rapid development of the medical industry, society's standards for nursing professionals are constantly rising. As a critical component of nursing education, the teaching quality of basic nursing courses directly affects the effectiveness of nursing talent cultivation. Currently, the teaching model of basic nursing courses faces numerous challenges, such as theoretical emphasis on teaching content, a singular teaching approach, and inadequate evaluation systems. These issues hinder the smooth translation of theoretical knowledge into practical skills, making it difficult to meet societal and industry expectations for nursing professionals.

2. Overview of the outcome-based education concept

2.1. Definition of outcome-based education

Outcome-based education (OBE) is an educational philosophy that focuses on the learning outcomes achieved by students. This concept advocates that every stage of educational activities should revolve around the learning outcomes that students can ultimately achieve, which differs from the traditional education model centered

on teaching content or teachers. The core of the OBE concept lies in clearly defining learning outcomes and reverse-planning the teaching process accordingly to ensure the effective achievement of these outcomes^[1]. This educational model emphasizes the cultivation of students' abilities and stresses that education should respond to the actual needs of society and students, aiming to cultivate talents who can adapt to future challenges.

2.2. Application of OBE in educational reform

When implementing the OBE educational model, the primary task of educators is to clarify specific and measurable educational goals that are closely connected to students' future career development. Subsequently, course design and implementation revolve around these predetermined learning outcomes, adjusting teaching content, methods, and evaluation accordingly. To promote students' active learning and practical ability, the OBE educational model encourages the adoption of diversified teaching methods, such as case-based teaching, project-based learning, and flipped classrooms. Simultaneously, the evaluation system also needs to be reformed, shifting from the traditional assessment of knowledge mastery to a more diversified and comprehensive evaluation of skill demonstration, including process evaluation, self-evaluation, and peer evaluation. From the teacher's perspective, the traditional teaching method focuses on teaching content as the core of instructional design. However, based on the OBE concept, the course's instructional design is a reverse design of training objectives based on social needs. This "reverse thinking" requires teachers to adopt appropriate teaching methods to explain knowledge points based on training objectives. Therefore, teachers need to fully study the training objectives, understand the advantages and disadvantages of each teaching method, and design teaching based on the teaching content and academic analysis. The implementation of the OBE concept has greatly improved teachers' teaching design abilities, enhanced their basic teaching skills, and further improved the teaching effectiveness of the course^[2]. In summary, the application of the OBE concept not only helps improve the quality of education but also cultivates high-quality talents that better meet social needs. Especially in the field of nursing education, it can effectively enhance the practical abilities and comprehensive qualities of nursing students, enabling them to better adapt to the modern medical environment.

3. Problems in current basic nursing course teaching

3.1. Analysis of deficiencies in the existing teaching model

In the teaching of basic nursing courses, a series of problems have gradually emerged. The lack of timely updates of teaching content and outdated textbooks make it difficult for students to access and learn the latest nursing knowledge. The teaching method is monotonous, with traditional teaching methods dominating and lacking the integration of new media technology, resulting in a dull classroom atmosphere, low student enthusiasm, and limited teaching effectiveness. At the same time, there is a gap between teaching and clinical practice. The teaching of nursing operations has not kept up with the development of medicine, and the items used in practical training do not match the disposable items used in clinical practice, affecting the practical application of students' skills. The teaching content does not match the actual needs of nursing positions, with too much emphasis on theoretical teaching and insufficient teaching of specialized nursing techniques, resulting in a disconnect between what students learn and actual job requirements. In response to these problems, teaching reform is imperative. It is necessary to update teaching content, introduce diversified teaching methods, strengthen the combination of theory and practice, and enhance teachers' clinical experience and teaching ability to cultivate nursing professionals who meet social needs.

3.2. The gap between demand and educational status quo

In the current rapid development of the medical industry, society's expectations for nursing professionals are gradually rising. Not only solid professional knowledge but also comprehensive qualities such as communication skills, teamwork spirit, and innovation abilities are emphasized ^[4]. However, there is a significant gap between the existing nursing education model and these diversified social needs. As a highly practical subject, the practical aspects of basic nursing are often marginalized in the teaching process, making it difficult for many students to quickly integrate into the clinical work environment and flexibly apply theoretical knowledge to actual nursing operations after completing their studies ^[5].

In addition, the cultivation of students' professional literacy, including the establishment of professional ethics, the enhancement of legal awareness, and the improvement of social responsibility, has not been fully addressed and strengthened in the current education system. The uneven distribution of educational resources is also becoming increasingly prominent, and the quality of teaching varies among different regions and institutions, which undoubtedly exacerbates the uneven development of nursing talent quality. The pace of educational reform has not kept up with the new dynamics of society and the industry, and the updating of teaching content and methods has lagged, which can no longer meet the needs of modern nursing education.

4. Teaching model reform based on the OBE concept

4.1. Resetting of course objectives

Under the guidance of the OBE education philosophy, the focus of education has shifted from traditional knowledge imparting to skill cultivation as the core. This transformation in the educational model ensures that students not only master necessary nursing skills but also achieve comprehensive improvement in clinical thinking, communication skills, and lifelong learning abilities upon completing their studies. To implement this philosophy, educators have carefully designed a series of specific and measurable learning outcomes, aiming to enable students to independently complete basic nursing operations, effectively communicate with patients and their families, and use critical thinking to solve various challenges encountered in clinical practice.

The setting of these course objectives is closely aligned with the professional standards and actual needs of the nursing industry, ensuring synchronization between educational outcomes and industry development. Through this approach, the education system not only provides students with a solid theoretical knowledge foundation but, more importantly, cultivates their abilities to adapt to the rapidly changing medical environment, solve complex clinical problems, and continuously improve themselves ^[6]. Such an educational model not only lays a solid foundation for students' career development but also contributes to the overall progress and continuous innovation of the nursing industry.

4.2. Innovation in teaching methods and content

In terms of teaching methods, the case-based teaching method is adopted, which introduces real clinical cases to enable students to deepen their understanding of theoretical knowledge through case analysis and improve their skills in solving practical problems. The application of a blended learning model, combining online and offline resources, brings a more autonomous learning experience to students, enhancing the flexibility and interactivity of learning. Role-playing and simulation training have become part of the teaching, allowing students to improve their nursing skills and clinical decision-making abilities through practice in a simulated clinical environment. Meanwhile, the promotion of interdisciplinary cooperation facilitates the integration of nursing with other medical fields, broadening students' knowledge horizons and aiming to cultivate talents with

comprehensive qualities. To achieve a perfect combination of theory and practice, the teaching content has been adjusted, and practical class hours have been increased to ensure that students gain rich practical experience while learning theory.

4.3. Reform of assessment and evaluation systems

In terms of the evaluation system, a formative evaluation strategy is adopted, focusing on students' learning processes and providing timely feedback to guide them in optimizing their learning methods and strategies. The evaluation methods are diversified, incorporating written tests, operational assessments, clinical internship evaluations, and group discussion performances to comprehensively measure students' abilities and qualities. Simultaneously, students are encouraged to conduct self-evaluation and peer evaluation to enhance their self-reflection and critical thinking skills. To ensure the long-term effects of educational outcomes, a graduate tracking and evaluation system has been established to collect employment and career development information, providing a basis for continuous improvement of the teaching plan ^[7]. These reform measures contribute to a better alignment of the teaching model based on the OBE concept with the educational needs of the nursing profession, thereby cultivating high-quality nursing talents with both theoretical knowledge and practical abilities.

5. Practical exploration and case analysis

5.1. Application of the OBE concept in basic nursing courses

At the School of Nursing of Dali University, comprehensive reforms have been implemented in basic nursing courses based on the OBE concept. The course objectives focus on cultivating students' mastery of basic nursing operation skills, clinical thinking abilities, and patient communication skills. Each learning module has set clear learning outcomes. For example, in the "Measurement of Vital Signs" module, students learn to accurately measure and record vital signs such as body temperature, pulse, respiration, and blood pressure ^[8]. Meanwhile, Shantou University Medical College has innovated its teaching methods by adopting a flipped classroom model. This model shifts the learning of theoretical knowledge to pre-class, while classroom time is dedicated to in-depth discussions, practical operations, and case analyses, effectively enhancing student engagement and learning efficiency ^[9]. Furthermore, a simulated hospital ward has been established at a certain nursing college where students undergo training in basic nursing operations such as changing bed sheets and performing sterile techniques. With teachers and other students playing the role of patients, this provides students with a near-real operational experience.

5.2. Challenges and solutions in practice

During the implementation of the teaching model reform based on the OBE concept, the college faced challenges such as poor student adaptability, the need for teacher capacity improvement, the establishment of an evaluation system, and uneven resource allocation. To help students adapt to the new model, the college conducted early publicity and training on the OBE concept, allowing students to understand the advantages and expected learning outcomes of the new model. Guidance on learning methods and time management was also provided. Regarding teacher capacity improvement, the college organized specialized training to enhance teachers' abilities in teaching design and evaluation under the OBE teaching model and encouraged them to participate in teaching research to continuously optimize teaching methods. In terms of the evaluation system, the college established a reform team to research and implement a diversified evaluation system and developed

an online evaluation platform to record and provide feedback on students' learning progress in real time. To address resource allocation issues, the college optimized resource allocation, increased the number of simulation laboratories, and extended their opening hours to ensure that every student had sufficient opportunities for practical operations. Through these practical explorations and case analyses, we have verified the feasibility and effectiveness of the OBE concept in basic nursing courses and gradually overcome the challenges faced through reasonable solutions.

6. Reform effectiveness evaluation

6.1. Evaluation criteria for teaching quality improvement

In the comprehensive assessment of teaching quality, the primary focus is on the achievement of preset learning outcomes for the course. This covers a comprehensive evaluation of students' comprehensive abilities, including basic nursing theory, practical skills, clinical thinking, and communication skills. Meanwhile, student satisfaction is an essential part of evaluating teaching quality. Through regular surveys and individual interviews, students' feelings and opinions on the teaching process, resource allocation, and teaching effectiveness are comprehensively collected. The teaching ability of teachers under the new teaching model is also crucial. Their performance in teaching planning, classroom control, student guidance, and evaluation feedback is carefully assessed, considering their professional development and teaching innovation as key to improving teaching quality. Additionally, the utilization efficiency of teaching resources is evaluated in depth, involving the frequency of use and actual effectiveness of teaching aids such as laboratories and simulation equipment, to ensure maximum utilization of teaching resources and continuous quality improvement.

6.2. Improvement of student abilities and qualities

When evaluating teaching quality, the achievement of preset learning outcomes for the course is the primary criterion. This involves a comprehensive evaluation of various aspects such as students' basic nursing theoretical knowledge, practical skills, clinical thinking, and communication skills. Student satisfaction is a key indicator for measuring teaching quality. Feedback from students on the teaching process, resources, and effectiveness is collected through surveys and interviews^[10]. Simultaneously, teachers' abilities in teaching design, classroom management, student guidance, and evaluation feedback are evaluated, considering their professional growth and teaching innovation as references for teaching quality improvement. Additionally, the frequency and effectiveness of teaching resource usage are assessed to ensure efficient utilization and continuous improvement of laboratories, simulation equipment, and other resources.

In assessing theoretical knowledge mastery, various methods such as written tests, oral exams, and case analyses are employed to measure students' knowledge retention. Changes in performance before and after the reform are compared to analyze effectiveness. For practical skill improvement, evaluations are conducted through operational assessments, clinical internships, and simulation exercises, with particular emphasis on emergency response capabilities and proficiency in clinical operation techniques. The evaluation of clinical thinking abilities focuses on clinical case analysis, problem-solving, and critical thinking tests. Communication and collaboration skills are measured through group discussions, role-playing, and interactions during clinical internships. The process of students' self-learning and growth is tracked through self-evaluation, learning logs, and growth records, reflecting their autonomy and motivation for continuous learning during the learning process. Through this multi-dimensional comprehensive evaluation, we can fully grasp the actual effectiveness of the teaching model reform based on the OBE concept in basic nursing courses, providing a solid foundation

and clear direction for the further advancement of educational reform.

7. Conclusion

This article provided an in-depth analysis of the reform and practical implementation of the teaching model for basic nursing courses based on the OBE concept. From theoretical construction to operational implementation, and reform initiatives to effectiveness evaluation, it comprehensively revealed the criticality and urgency of this teaching model reform. Reflecting on the journey of reform, the profound significance of the OBE concept in the field of nursing education becomes evident. Not only does it offer a clear direction for educational reform, but it also effectively stimulates teachers' enthusiasm for teaching and students' academic interests. However, educational reform is never-ending, and we will continue to explore, summarize experiences, and make continuous improvements in future teaching practices to advance the development of nursing education.

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Teaching Reform of Communication Application Development Course under the Background of Engineering Education Accreditation

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Abstract: This study focuses on the teaching reform of the communication application development course based on the core requirements of engineering education accreditation. To address key challenges such as the disconnection between software and hardware teaching and insufficient practical skills among students, a project-driven “learning-practice-application” teaching model is proposed. By optimizing course content, innovating teaching methods, and introducing university-industry collaboration mechanisms, the reform aligns the curriculum more closely with engineering education standards and industry demands. The approach significantly enhances students’ comprehensive skills, practical abilities, and employability. This study provides theoretical foundations and practical strategies for the teaching reform of courses in communication engineering.

Keywords: Engineering education accreditation; Communication application development; Teaching reform; Software-hardware integration; University-industry collaboration

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1. Introduction

Engineering education accreditation, as an important global trend in the field of engineering education, aims to cultivate high-quality engineering professionals capable of addressing complex engineering problems and competing internationally^[1-3]. Against this backdrop, the communication application development course, as one of the core courses in the communication engineering discipline, plays a pivotal role in enhancing students’ comprehensive skills and achieving the objectives of engineering education accreditation^[4,5].

The rapid advancement of communication technology imposes higher demands on engineering talent, requiring students to possess diverse skills in software development, hardware design, and system integration. However, traditional course content often lags behind technological developments, with insufficiently designed practical components and significant gaps between academic training and industry requirements. This situation

not only hinders the development of students' abilities to solve complex engineering problems but also undermines their career competitiveness. Consequently, there is an urgent need for systematic teaching reforms to establish a more scientific and reasonable curriculum system and teaching methodologies, providing students with a more effective and industry-relevant learning experience ^[6,7].

This study aims to explore and implement a project-driven teaching model grounded in the principles of engineering education accreditation. The goal is to enhance students' comprehensive practical skills and interdisciplinary problem-solving abilities, offering robust support for improving the communication application development course.

2. Current teaching status and analysis

2.1. Teaching status and background analysis

The core objective of engineering education is to cultivate high-quality engineering professionals with innovation and practical abilities. The communication application development course, as an essential component of the communication engineering discipline, covers various fields such as web development and embedded system design. It is a critical course for students to build their professional knowledge base and enhance their practical skills. However, the current curriculum suffers from outdated content and relatively traditional teaching methods, creating a significant gap with the rapidly evolving demands of the industry.

The lag in curriculum content and limitations in teaching methodologies directly impact the cultivation of students' comprehensive capabilities, particularly in addressing complex engineering problems. Traditional teaching models fail to incorporate cutting-edge industry technologies promptly, and students lack opportunities to connect their learning with real-world engineering applications. This disconnect undermines the effectiveness of the course in fostering innovation and practical abilities. Systematic teaching reforms are urgently needed to align the curriculum more closely with the goals and requirements of engineering education accreditation.

2.2. Key issues

The current communication application development course faces two primary challenges: the disconnect between software and hardware teaching and insufficient student practical skills. Firstly, in traditional communication engineering education, application development and hardware design courses are often taught independently. This separation makes it difficult for students to effectively integrate software and hardware knowledge. Such a disconnect hampers the holistic development of students' competencies and falls short of meeting the interdisciplinary integration requirements of engineering education accreditation. In modern communication engineering practice, solving complex engineering problems often demands seamless collaboration between software and hardware technologies. Therefore, introducing interdisciplinary integration into teaching is imperative to help students master the skills required for collaborative software-hardware development.

Secondly, the existing teaching model places excessive emphasis on theoretical knowledge, neglecting the design and implementation of practical components. This traditional approach results in students struggling to apply theoretical knowledge to real-world scenarios, failing to meet the industry's high expectations for practical problem-solving and operational skills. The lack of sufficient practical opportunities leaves students underprepared for independent operation and teamwork in real engineering projects. To address this issue, it is essential to enhance practical components in the curriculum, offering students hands-on experiences through real projects or simulated scenarios. This approach will comprehensively improve their practical abilities and

overall competencies.

3. Teaching reform

3.1. Teaching model design and curriculum integration

Innovating teaching models and integrating curriculum content are central goals of teaching reform, focusing on providing students with a comprehensive and application-oriented learning experience. Based on extensive literature research and case studies, this study proposes a “learn-practice-apply” teaching model, systematically designed for the communication application development course. This model encompasses content such as web front-end development, smart terminal development technologies, Java programming, microcontroller principles and applications, and embedded system design, ensuring strong alignment between the curriculum and real-world projects.

The model also emphasizes interdisciplinary knowledge integration and collaborative learning, enabling students to acquire comprehensive knowledge from different disciplines to tackle complex engineering problems. To achieve this, the curriculum content has been meticulously integrated to form a cohesive syllabus that transitions students from theoretical learning to practical project application. Through systematic course design, students are equipped to master key skills in software development, hardware design, and embedded systems, achieving deep integration of software and hardware in project practice and significantly enhancing their overall competence.

3.2. Project practice design and application scenario simulation

The design of practical components is a critical aspect of teaching reform, aiming to provide students with extensive hands-on experience through real or simulated application scenarios. Based on the course content, this study has designed several comprehensive projects with significant challenges and practical relevance. These projects span multiple levels, from software development to embedded system design, and are integrated throughout the teaching process to ensure students gain a deep understanding and flexible application of their knowledge during project practice.

Additionally, considering the characteristics of practical applications in communication engineering, various simulated scenarios have been developed, such as communication system simulations and small-scale communication device development. These scenarios help students closely connect theoretical knowledge with real-world applications. Within these contexts, students not only experience the challenges of real engineering but also enhance their logical analysis and innovative abilities as they solve actual problems. This practice-based teaching method effectively improves students’ problem-solving skills and engineering literacy, laying a solid foundation for their future career development.

3.3. University-industry collaboration

University-industry collaboration provides crucial support for teaching reform by introducing enterprise resources and industry expertise, further enhancing the practicality and forward-looking nature of the curriculum. Joint development of real projects by schools and enterprises offers students invaluable practical opportunities. Under the guidance of industry mentors, students deeply engage in project development, gaining a comprehensive understanding of industry needs and workflows, thereby strengthening their professional skills and employability.

Moreover, university-industry collaboration offers a scientific basis for dynamically adjusting course

content. Through close communication with industry experts, schools can stay informed about industry trends and technological demands, ensuring that teaching content keeps pace with the times. This constructive interaction not only improves the adaptability of the curriculum but also provides strong support for cultivating high-quality, application-oriented talents tailored to industry needs.

4. Conclusion

Under the framework of engineering education accreditation, the teaching reform of the communication application development course serves as a critical pathway to improving student capabilities and teaching quality. This study addresses key challenges such as the disconnect between software and hardware instruction and insufficient practical skills by optimizing course content, innovating teaching models, and strengthening university-industry collaboration. These efforts have significantly enhanced students' comprehensive competencies and adaptability to professional environments.

In the future, this research will further refine the teaching model, continuously monitor industry technological advancements, and incorporate more forward-looking content into the curriculum design. These initiatives aim to deepen the integration of engineering education with industry needs, providing stronger support for cultivating high-quality, application-oriented talents in the field of communication engineering.

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A Visualization Analysis of Problem-Based Learning in Colleges Using VOSviewer

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Abstract: In order to gain insight into the current research status and development trend of problem-based learning (PBL) in colleges and universities, this study employs the bibliometric method to conduct statistical and analytical studies based on the examination of journal papers and review papers within the Web of Science (WOS) database. The objective is to provide a reference point for research in related fields. The findings indicate a sustained expansion in PBL research output at universities, with the United States accounting for most documents in the field, while European research institutions such as Aalborg University and Maastricht University are at the forefront. Nevertheless, the density of collaborative networks between authors is relatively low, and cross-institutional and interdisciplinary collaboration still requires further strengthening. The majority of research results are published in academic journals such as Academic Medicine and the International Journal of Sustainability in Higher Education. Presently, the focal point of PBL research in colleges and universities is undergoing a transition from a “single-discipline focus” to an “interdisciplinary integration.” This integration is profoundly intertwined with the nascent fields of modern educational technology and education for sustainable development, thereby offering a novel avenue for the advancement of pedagogical approaches and educational equity.

Keywords: Problem-based learning; Web of Science; VOSviewer; Visualization analysis

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1. Introduction

Problem-based learning (PBL) represents an innovative teaching method initially proposed in the 1960s at McMaster University School of Medicine in Canada. The objective of this pedagogical approach is to cultivate students' capacity to solve complex, real-world problems ^[1]. This pedagogical approach is centered on the student, with guidance from the teacher facilitating a process of learning through specific problems. This enables students to enhance their abilities in self-directed learning, innovation, and teamwork through active exploration.

In recent years, there has been a growing recognition of the value of new teaching methods, with an

increasing application of PBL pedagogy in university education. This has extended to a range of disciplines, including physics, language, medicine, and beyond^[2,3]. In comparison with traditional pedagogical approaches, PBL has been demonstrated to facilitate the enhancement of students' motivation, interest, and problem-solving abilities, as well as their comprehension and practical application of problems^[4].

Nevertheless, despite the growing body of research on PBL, there is a paucity of comprehensive and systematic analyses of the current status and development of PBL in the field of university education. In order to address this gap in the literature, this study employs a bibliometric approach, utilizing the published research literature as a basis for analysis. The VOSviewer tool is employed for the visualization and analysis of research on PBL pedagogy.

The main purpose of the study is to reveal the research publication trend of PBL in higher education, analyze the distribution characteristics of authors, institutions, journals, and countries, sort out the current research status, and explore the future development trend through keyword co-occurrence analysis and other methods. It aims to provide a scientific basis for subsequent related research and promote the in-depth development and widespread application of PBL pedagogy in higher education.

2. Methodology

2.1. Research tools

In recent years, knowledge mapping has emerged as a novel research method within the field of infometrics. It employs a visual representation of the interrelationships and development processes of knowledge, utilizing citation analysis, co-occurrence analysis, and visualization analysis. This paper employs the VOSviewer bibliometric tool for knowledge mapping. In comparison with other similar software, the software guarantees the scientific rigor of the knowledge map to the greatest extent, rather than compromising the accuracy of the co-occurrence of the relationship between the nodes at the expense of ensuring the clarity of the representation^[5]. The software is capable of presenting a variety of network views, including clustering, labelling, and density, which are effective tools for researchers to view knowledge evolution, analyze hotspots in a field, and mine thematic clusters. Concurrently, the acquired data are subjected to comprehensive analysis on the Web of Science platform's own online analytical functions. The data were summarized and visualized in terms of the number of publications, authors, institutions, countries, co-occurrence networks, and so forth. An overall analysis of research on problem-based learning pedagogy in universities was then carried out.

2.2. Data sources

The Web of Science (WOS) core collection database from Corevision was selected as the literature source, and the following search conditions were set: the database was selected as the Web of Science core collection, the citation index was set as Science Citation Index Expanded (SCI-EXPANDED)--1975-present and Social Sciences Citation Index (SSCI)--1975-present, an advanced search was used with TS=((“Problem- based learning”)AND(“college*” or “university*”))^[6,7] as the search formula, with a search period of 2004–2024 and the type of literature restricted to articles and reviews for a precise search. A total of 1,051 documents matching the topics were retrieved. The time of the search is December 1, 2024, and the specific selection process is shown in **Figure 1**.

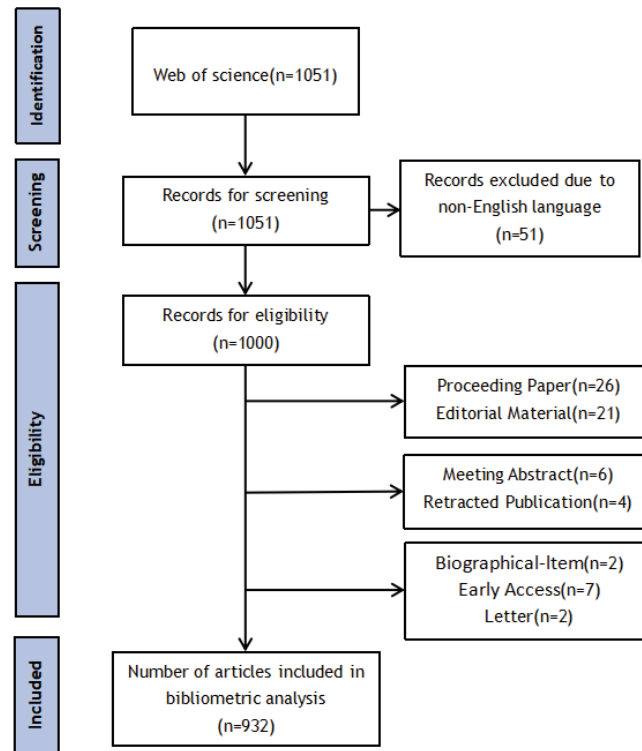


Figure 1. PRISMA flow diagram

3. Results and discussion

3.1. Research status on problem-based learning in college

3.1.1. Statistical analysis of the annual number of publications

A total of 932 publications on problem-based learning in colleges and universities have been produced between 2004 and 2024. The earliest known literature on this topic was published in 1991 in the journal MEDICAL TEACHER^[8]. The number of annual publications serves as a benchmark for gauging the advancement of research in the field. It provides insight into the research trajectory of scholars in the field while reflecting the trend of relevant research in the field^[9]. The entire university's problem-based learning initiative can be divided into two distinct phases: the initial and stabilizing period and the subsequent rapid growth period. The initial and stabilizing period, spanning from 2004 to 2015, is characterized by considerable fluctuations in the annual publication volume, with an overall trend that remains between 40 and 50 articles. The initial value was relatively low in 2004 (31 articles), before gradually increasing to reach a high point in 2009 (52 articles). This reflects the initial development stage of PBL research in colleges and universities. The overall trend is more stable, although there is a decline in some years (e.g., 34 articles in 2012). This suggests that the concept of PBL is gradually gaining attention in teaching and learning in higher education, although its research scope and application remain in the exploratory phase. Following 2016, the number of publications increased steadily, rising from 51 in 2016 to a high of 72 in 2021, but declining to 46 in 2023 (**Figure 2**). This phase demonstrates a notable surge in research activity, particularly between 2020 and 2022. This may be attributed to the rising popularity of online learning, which has fostered a renewed interest in PBL. Despite the decline in 2023, the overall level remains higher than at the outset, indicating that the diversification of teaching and learning modes has contributed to an increase in the number of publications.

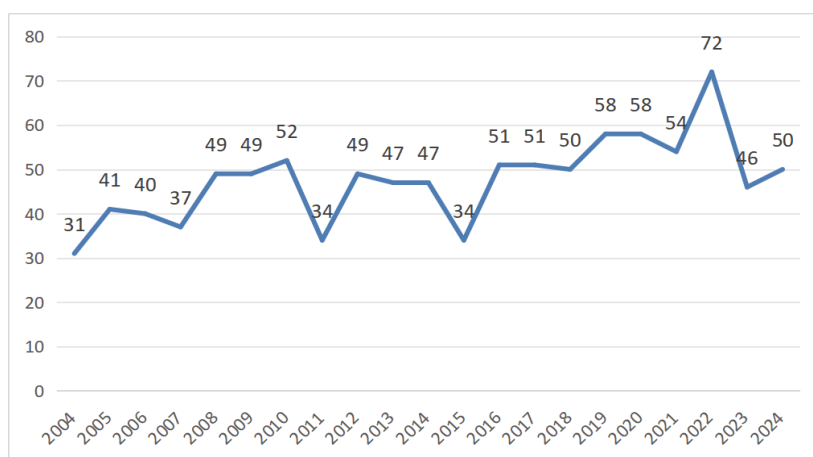


Figure 2. Annual distribution of publications on problem-based learning in colleges and universities (2004–2024)

3.1.2. Author co-occurrence analysis

Author co-occurrence analysis provides a visual representation of the highly productive authors and their collaborations in the field, which is useful for grasping the key forces in the research field^[10]. Over the past two decades, 932 core documents on problem-based learning in universities have involved 3,261 authors, and 28 core authors have been identified through the application of Price’s law, which establishes a minimum threshold of three publications per author. The size of the dots indicates the number of publications by each author, with larger dots representing a greater number of publications and, consequently, a more prominent role in the field. The lines between the dots represent the existence of mutual cooperation among the authors, as illustrated in **Figure 3**. With du, xiangyun, guerra, aida as the center, poulton, terry, ellaway, rachel h. as the center, schmidt, henk g. as the center, and schmidt, henk g. as the core author, the core author is the author who has published the most works. Wijnia, Lisette, and others demonstrate a more pronounced collaborative network with an increased number of collaborators. Nevertheless, the overall impression is that there is a relatively low level of collaboration between authors, with the majority of scholars working independently. The analysis demonstrates that the level of collaboration among the principal researchers in the field of problem-based learning in higher education is relatively low, and the interconnectivity is not particularly robust, even among high-output authors from the same institution. It is recommended that the leading role of the core authors be assumed with a view

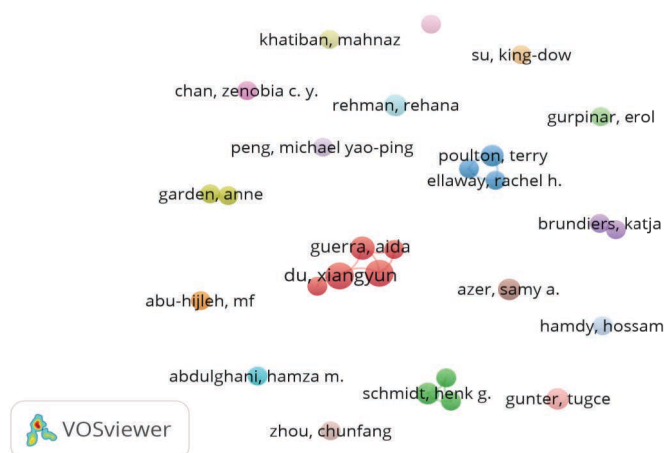


Figure 3. Visual map of author cooperation

to further strengthening the cooperative inquiry among researchers from the same institution, cross-institutional researchers, and researchers from different disciplines. This will facilitate the formation of a research synergy and promote the in-depth development of research in the field.

3.1.3. Analysis of institutional collaboration networks

The analysis of the issuing institutions can reflect the distribution and reserve of research power in the field of problem-based learning research in universities ^[11]. A total of 137 papers, representing approximately 14.7% of the total number of papers on the topic of problem-based learning in higher education, were published by the top 10 issuing institutions. This evidence suggests that these institutions are the primary contributors to research in this field. As illustrated in **Figure 4**, Aalborg University, Maastricht University, and the University of Hong Kong are situated at the core of the collaborative network, characterized by large nodes and frequent connections. This suggests their prominent role in academic leadership with regard to PBL research and dissemination. Similarly, Erasmus University and Rotterdam also occupy important nodes. Erasmus University Rotterdam also plays an important role in this context, demonstrating its influence in international PBL cooperation. With regard to the regional distribution of these institutions, Aalborg University and Maastricht University exemplify the intensive collaboration and compact network structure observed among European universities, thereby underscoring Europe's leading role in the promotion and application of problem-based learning. Furthermore, institutions such as Aalborg University and Erasmus University Rotterdam not only form close networks with regional higher education institutions (HEIs) but also establish cross-regional links with those in North America and Asia. Middle Eastern universities, such as King Saud University and Arabian Gulf University, are emerging as centers of cooperation in the region, including through collaboration with Europe. Asian universities, such as Hong Kong Polytechnic University and China Medical University, play a role in the network, but their involvement is relatively limited in comparison to the core universities in Europe and the United States. There is also room for improvement in terms of the frequency of cooperation.

In general, a limited number of institutions (e.g., Aalborg University, Maastricht University, etc.) occupy a central position and promote extensive multi-regional collaboration. Concurrently, some regions (e.g., the University of Sharjah, Gifu University, etc.) are emerging and demonstrating active involvement. In the future, it will be important for global PBL research to focus on strengthening the participation of disadvantaged regions and promoting interdisciplinary cooperation.

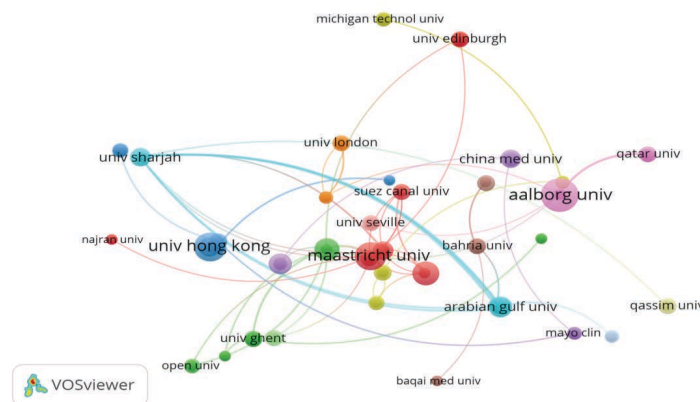


Figure 4. Visualization map of institutional cooperation (univ = university)

3.1.4. Analysis of literature citations

The citation count of a document serves as a direct indicator of its influence and contribution within its respective field. **Table 1** presents the top six most-cited articles in the field of problem-based learning (PBL) research in higher education. As shown in **Table 1**, the most frequently cited article is “The Flipped Classroom: A Course Redesign to Foster Learning and Engagement in a Health Professions School” by Jacqueline E. McLaughlin, published in 2014. During this period, research on PBL in higher education was entering a phase of steady development. In this study, McLaughlin effectively integrated the flipped classroom model with PBL, significantly enhancing students’ motivation and engagement, while fostering their critical thinking and problem-solving skills ^[12]. This innovative teaching approach provided a novel application context for PBL, enriching instructional practices and establishing an important research paradigm in medical education.

Furthermore, Katja Brundiers and Malathi Srinivasan are the most frequently cited authors, with Brundiers’ article having been cited 324 times and Srinivasan’s article having been cited 300 times. These high citations indicate that problem-based learning, as a student-centered instructional strategy, is receiving increasing attention from academics and educational practitioners. Furthermore, its theoretical and practical value has been widely recognized. The cited literature is primarily drawn from academic journals such as *Academic Medicine*, *International Journal of Sustainability in Higher Education*, and *Surgical and Radiological Anatomy*, which are the principal outlets for publishing research findings on problem-based learning in colleges and universities.

Table 1. Top six most cited papers in the Web of Science Core Collection Database

Title	Author	Journal	Citations	Average per year
The Flipped Classroom: A Course Redesign to Foster Learning and Engagement in a Health Professions School	Jacqueline E. McLaughlin	Academic Medicine	665	60.45
Real-World Learning Opportunities in Sustainability: From Classroom into the Real World	Katja Brundiers	International Journal of Sustainability in Higher Education	324	21.60
Comparing Problem-Based Learning with Case-Based Learning: Effects of a Major Curricular Shift at Two Institutions	Malathi Srinivasan	Academic Medicine	300	16.67
Do We Need Dissection in an Integrated Problem-Based Learning Medical Course? Perceptions of First- and Second-Year Students	Samy A. Azer	Surgical and Radiological Anatomy	250	13.89
First Year Medical Student Stress and Coping in a Problem-Based Learning Medical Curriculum	KJ Moffat	Medical Education	245	11.67
Problem-Based Learning: Influence on Students’ Learning in an Electrical Engineering Course	Aman Yadav	Journal of Engineering Education	236	16.86

3.1.5. Analysis of collaborative networks in major countries/regions

The data from the papers were imported into the VOSviewer (1.6.20) software for processing. In analyzing the cooperation network, the size of the circle is indicative of the corresponding country or region’s publication status. The connecting lines between the circles indicate the connection between individuals. A larger circle indicates a higher number of publications, while a more intensive connecting line signifies a stronger cooperation relationship. **Figure 6** comprises 50 network nodes, 168 links, and 8 clusters. The network nodes correspond to country names, with node size positively correlated with the number of documents. Links indicate the existence of a cooperative relationship between countries or regions. Furthermore, clusters can be used to

represent the proximity of cooperation between countries or regions. In the network, nodes and links within the same cluster are represented by the same color.

As illustrated in **Figure 5**, the United States of America occupies the largest node in the graph, indicating that it has published the greatest number of papers on problem-based learning research in higher education. Furthermore, the United States of America has more extensive and robust interconnectivity with several countries, including Germany, the People's Republic of China, Canada, and England. This suggests that these countries engage in frequent and close collaborative endeavors. Furthermore, China, England, Saudi Arabia, and Spain are also prominent nodes, indicating that they have made significant contributions to the field of problem-based learning in higher education. People's Republic of China has established robust collaborative relationships with Malaysia, Saudi Arabia, and other countries in Asia. This illustrates China's collaborative network within the Asian region. The United States and the People's Republic of China are identified as key players in facilitating cross-regional connections, fostering partnerships with numerous countries to bridge different regions. They serve as a conduit in the global network of cooperation, particularly facilitating connections between Europe and America with Asia. Concurrently, England also serves as a cross-European conduit, establishing robust connections with numerous European countries.

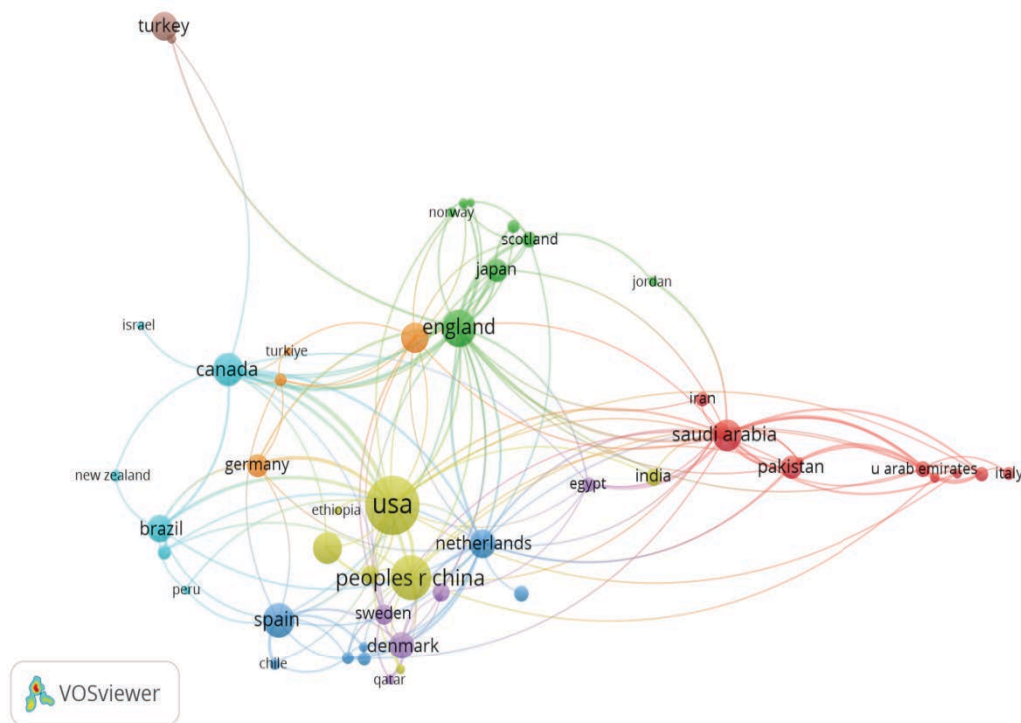


Figure 5. Countries/regions cooperation network

3.2. Trends in problem-based research relevant to college education

3.2.1. Keyword co-occurrence mapping

Keywords are a summary of the main content of the literature, and analyzing the keywords of related literature in a certain field can help to understand the research hotspots in this field^[13]. When selecting keywords, due to individual differences in the expression of some words, the phenomenon of multiple words is common, which may lead to inaccurate keyword co-occurrence mapping. In order to solve this problem, firstly, the

expressions of keywords in all the literatures are unified. For example, “problem based learning,” “problem-based learning (pbl),” “pbl,” “problem-based learning, methods,” can be harmonized as “problem-based learning”; “student perceptions” can be harmonized as “perceptions,” “academic-achievement” can be harmonized as “achievement,” and so on. To obtain the graph displayed in **Figure 6**, the relevant settings are run. Each node represents a keyword, with the size of the keyword indicating the frequency of that keyword. The keywords are ordered according to frequency, from the highest to the lowest. The keywords with the highest frequency are problem-based learning (525 times), education (204 times), university (124 times), medical education (118 times), student (170 times), performance (61 times), curriculum (125 times), and knowledge (56 times). In conjunction with the mapping, it becomes evident that the primary focus of PBL-related research in higher education is on pedagogical innovation, curriculum design and implementation strategies, student learning experience, and effectiveness assessment in higher education, with a particular emphasis on the application in medical and science education. This reflects the significant value of PBL in enhancing knowledge, skills, and critical thinking.

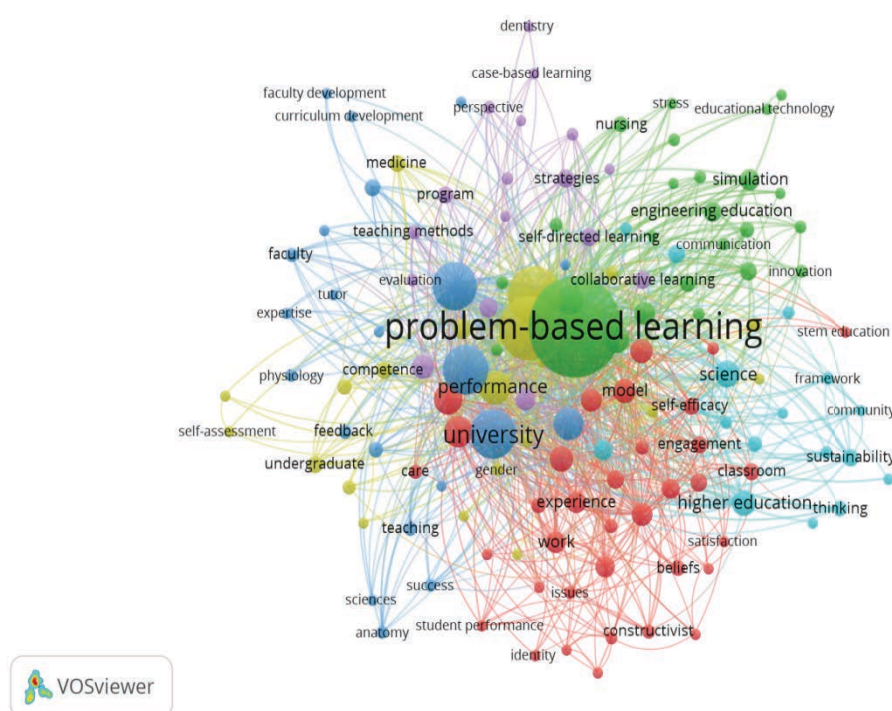


Figure 6. Keyword co-occurrence mapping

3.2.2. Keyword co-occurrence timeline analysis

The visualization maps were selected based on the frequency of occurrence of the keywords, with a minimum frequency of three occurrences and obtained along the time axis. The size of the node representing a keyword is indicative of the frequency of occurrence. The color of each node represents the research area that is the subject of the greatest interest at a given point in time. The direction of the lines connecting the nodes indicates the direction of knowledge flow, with the color transitioning from purple to yellow in accordance with the temporal sequence. In **Figure 7**, the purple nodes represent the period preceding 2005, and the yellow nodes represent the period subsequent to 2020. The greater the number of nodes associated with a given keyword that are colored

an important area of research. Tiwari *et al.* ^[15] conducted a comparative analysis between PBL and case-based learning (CBL), concluding that CBL is more responsive to the needs of both students and faculty in medical education, particularly in terms of fostering lifelong learning, open-ended inquiry, and teamwork. Additionally, it offers an alternative to traditional PBL group instruction. Furthermore, a study conducted by Srinivasan *et al.* ^[16] demonstrated that PBL offers substantial benefits over the conventional lecture format (lecturing) in fostering critical thinking skills in nursing students.

Furthermore, group discussion, as a crucial element of PBL instruction, has demonstrated substantial impacts on fostering students' collaborative abilities, critical thinking, and problem-solving competencies. The integration of ICT technologies, such as computer-supported PBL (CSPBL) and distributed PBL (DPBL), has introduced new avenues for enhancing the adaptability of PBL teaching and distance learning. Nevertheless, research in this phase is primarily concerned with comparative analyses of different teaching methods, and the comprehensive integration of PBL in actual teaching and learning remains in the initial stages of investigation.

In short, the research conducted during the initial phase has established a theoretical foundation and practical experience that inform the implementation of PBL in medical and nursing education. Through the comparative analysis of teaching methods and techniques, it has yielded valuable insights that will inform the subsequent advancement of research and interdisciplinary applications of PBL.

The second phase is the deepening and innovation phase of PBL research in higher education (2011–2024). During this period, the research field is undergoing constant expansion and integration with a variety of educational theories and technological tools. Additionally, a significant number of new themes and keywords have emerged, including “Engineering Education,” “Curriculum Change,” and “Education for Sustainable Development.” There is application of game-based learning, hypermedia systems, multimedia, foreign language education, applications and education for sustainable development in the classroom. The field of foreign language education has also seen applications in the field of chemistry. The focus of our research has shifted gradually from single-discipline teaching practices to interdisciplinary and cross-field educational innovations.

Yadav *et al.* ^[17] investigated the potential of problem-based learning in an undergraduate electrical engineering program. Their findings indicated that this approach facilitated students' comprehension of concepts within the specialized curriculum, enhanced their problem-solving abilities, and was an effective strategy for improving academic performance. Kerr and Yan ^[18] implemented a problem-based learning approach in a chemistry laboratory course by posing and solving authentic research problems. This approach stimulated students' interest and motivation to learn, and improved students' problem-solving skills and overall retention. Furthermore, PBL combined with augmented reality (AR) mobile games and game-based learning significantly improved the interactivity of the learning environment and student engagement. For example, Guerra ^[19] investigated the effectiveness of gamified learning and PBL theory in language teaching, exploring the potential of AR technology as a complement to traditional media (e.g., print materials) in this context. Furthermore, Wiek *et al.* ^[20] integrated problem-based and project-based learning approaches in higher education, highlighting the enhancement of diverse student competencies in the process of formulating and resolving intricate problems, which plays a pivotal role in Education for Sustainable Development (ESD). Meanwhile, Tejedor *et al.* ^[21] asserted that the integration of ESD has become a central topic in engineering education. The study demonstrated that, despite the fact that PBL and ESD share principles such as interdisciplinary collaboration and learning, they continue to encounter challenges in practice, which constrains the comprehensive integration of sustainable development.

Secondly, the advent of online education has also stimulated innovation in the application of PBL.

Aslan ^[22] investigated the role of problem-based learning in an online real-time classroom, and the results demonstrated that PBL was efficacious in enhancing students' academic achievement, problem-solving abilities, and interaction levels. Furthermore, Lee ^[23] investigated the utilization of computer-supported problem-based learning (CPBL) in medical education and discovered that, despite CPBL exerting a constrained overall influence on pedagogical approaches, it engendered certain alterations in students' expectations and perceptions of the tutor's role in group activities, which were closely associated with students' familiarity with the technology. In summary, this phase of PBL research has furnished invaluable support for enhancing educational efficacy, advancing curriculum reform, and attaining the Sustainable Development Goals (SDGs) through technology integration, innovative online educational models, and cross-disciplinary integration. Furthermore, it has established a foundation for future practical advancement in optimizing educational models and applying theory.

4. Conclusion

The development of PBL research in higher education serves to confirm the far-reaching impact of the trend of "student-centered" change in education. The core concept of this trend goes beyond the traditional mode of knowledge transfer, focusing instead on the cultivation of students' comprehensive abilities, innovative thinking, and sustainable development. This shift has facilitated the innovation of teaching modes in higher education and provided a crucial framework for advancing educational equity and quality improvement. At the present time, PBL research has progressed from the initial phase of investigation, which was characterized by a single-discipline focus, to a period of rapid development, during which there has been a shift towards multidisciplinary integration. Additionally, the focus of research has expanded from a comparative analysis of teaching modes and the construction of theoretical frameworks to encompass the practice of interdisciplinary application, technological integration, and innovative pedagogies. The theoretical and practical value of PBL is widely acknowledged by the international academic community. However, there is still scope for improvement in cross-institutional and cross-disciplinary collaboration, particularly in the promotion and application of PBL in the fields of social sciences, humanities, and vocational education, which require further exploration.

It is recommended that in the future, PBL research in colleges and universities should be closely integrated with emerging technologies such as artificial intelligence, big data, and virtual reality. This integration should be undertaken in order to achieve the optimization of teaching methods and the personalization of educational experience. This can be achieved by constructing a more adaptive, creative, and inclusive learning model. Meanwhile, PBL, as an open and flexible teaching strategy, merits further investigation for its potential in addressing real-world complex problems and fostering innovative thinking. Driven by globalization and technological innovation, research into PBL in colleges and universities will continue to deepen and promote the transformation of the teaching mode from a focus on a single discipline to interdisciplinary integration. This will open up new paths for the future development of education and play a greater role in the transformation of human society into a knowledge-based economy. As a result of the ongoing transition of human society towards a knowledge-based economy, it will assume a more prominent position.

Disclosure statement

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Application of the Understanding by Design Framework in Chinese Clothing Culture Education

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Abstract: This study examines the application of the Understanding by Design (UbD) approach to enhance students' cognitive, affective, and psychomotor learning domains, as well as their intercultural communication competence, in the Introduction to Chinese Culture course. UbD, a curriculum design framework emphasizing deep understanding over rote memorization, employs a "backward design" process to help students achieve a profound comprehension of Chinese culture and its modern implications. Through this approach, students also develop critical intercultural communication skills. The study offers helpful strategies for integrating English language teaching with Chinese cultural education, providing practical insights for curriculum development that bridges linguistic and cultural learning.

Keywords: Understanding by Design approach; Three domains of learning; Intercultural communication competence; Chinese cultural education; Backward design

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1. Introduction

Culture reflects a nation's history, values, and identity, connecting generations while fostering unity and resilience. Preserving and understanding cultural heritage sustains national pride and equips individuals with intercultural competence, essential for thriving in a globalized society. Chinese clothing culture exemplifies the integration of material culture and ritual propriety, with concepts like "sitting properly with correct attire" highlighting moral values and social etiquette. Hanfu (traditional Chinese attire), rooted in Han culture's rituals, transcends practicality, symbolizing millennia of material and spiritual heritage. Its influence on neighboring traditions, such as Korea's Hanbok, underscores the dynamic cultural exchange within East Asia.

However, university-level cultural education often suffers from limited depth and fragmented understanding^[1]. By applying the Understanding by Design (UbD) framework, this study reimagines course planning to address these challenges. The Chinese Clothing unit demonstrates how the UbD approach fosters meaningful engagement, cultural understanding, and intercultural competence, empowering students to connect

deeply with their own culture while appreciating others.

2. The Understanding by Design approach

The UbD framework, developed by Grant Wiggins and Jay McTighe, emphasizes deep understanding and meaningful learning over rote memorization ^[2,3]. By focusing on desired outcomes, UbD aims to equip students with enduring understandings and transferable skills that extend beyond the classroom. This approach guides students to grasp core concepts and apply their knowledge in diverse contexts, fostering authentic learning experiences.

When applying UbD to the Introduction to Chinese Culture course, teachers begin by interpreting the objectives of each cultural unit. They identify overarching “big ideas,” align them with ideological and political education, and design course units with these end goals in mind. This backward design process unfolds in three key stages ^[2-5]:

(1) Stage 1: Identifying desired results

The first stage defines the learning outcomes for each unit. Teachers set “Big Ideas” and “Essential Questions” to create a cohesive framework that connects the course content. For example, in teaching traditional Chinese clothing, big ideas might explore how clothing reflects cultural identity and societal values. Essential questions like “How does traditional Chinese clothing reflect historical and social values?” guide students toward a deeper understanding of cultural heritage.

(2) Stage 2: Determining acceptable assessment evidence

In this stage, teachers design assessments to measure students’ understanding and their ability to apply knowledge in real-world contexts. Assessment methods include quizzes, essays, presentations, and discussions. For example, students might compare traditional Chinese clothing with modern attire, analyzing cultural implications and presenting their findings. These assessments help refine teaching strategies and ensure that students’ intercultural communication skills are continually developed.

(3) Stage 3: Planning learning experiences and instruction

Based on the objectives and assessments, teachers design engaging, interactive activities to deepen students’ exploration of the big ideas. Activities might include analyzing historical artifacts, group discussions on the evolution of Chinese clothing, or role-playing intercultural scenarios. These activities foster critical thinking, problem-solving, and self-directed learning, preparing students to navigate a multicultural world with enhanced cultural awareness and competence.

3. Three domains of learning and intercultural communication competence

3.1. Three domains of learning

Effective course design integrates cognitive, psychomotor, and affective domains of learning to cultivate a holistic understanding ^[6]. In the UbD framework, when applied to Chinese clothing culture and interwoven with Hanbok, this approach not only deepens students’ knowledge but also enhances their intercultural communication competence by fostering comparative analysis and cultural appreciation. The development of intercultural communication competence—defined as the ability to effectively and appropriately interact with individuals from diverse cultural backgrounds—relies on the integration of three domains of learning: cognitive (knowledge), psychomotor (skills), and affective (attitudes).

3.1.1. Cognitive domain

The cognitive domain involves the development of mental skills and knowledge acquisition. In this course, students analyze the historical evolution, symbolic meanings, and cultural values of Hanfu and Hanbok. For instance, they explore how Confucian principles influenced clothing in both cultures, emphasizing modesty and hierarchical order ^[7]. While uncovering shared values, they also examine differences, such as Hanfu's layered robes and Hanbok's high-waisted skirts, reflecting unique geographical and societal influences. Students study garments like Hanfu worn by scholars and ceremonial Hanbok worn by royalty to understand their roles as cultural symbols ^[7,8]. These comparisons foster critical thinking and a nuanced appreciation of cultural narratives.

3.1.2. Psychomotor domain

The psychomotor domain focuses on physical skills and practical applications. Students engage in hands-on activities such as presentations, discussions, and collaborative projects. Through visual analyses, they compare Hanfu's straight-lined designs with Hanbok's structural elements like the chima (skirt) and jeogori (jacket) ^[8]. Workshops on identifying patterns, colors, and materials help students connect theoretical knowledge to tactile experiences. These activities enhance their understanding of craftsmanship and allow them to explore how traditional clothing shapes posture, movement, and social interactions in different cultural contexts.

3.1.3. Affective domain

The affective domain addresses emotions, attitudes, and values. Students reflect on the cultural significance of Hanfu and Hanbok, exploring how these garments evoke national pride and symbolize cultural revival in modern China and Korea. Discussions and reflective writing encourage students to consider how traditional clothing fosters identity and belonging. This process nurtures respect for cultural heritage and empathy for other traditions, promoting mutual understanding and global awareness.

By aligning the three domains of learning with an intercultural perspective, the course integrates moral education and intercultural understanding. Confucian ideals like harmony and mutual respect are woven into the curriculum, fostering values that transcend cultures ^[7]. Through the UbD approach, students gain an appreciation for their own culture while developing openness to others. Exploring Hanfu and Hanbok enriches the content, equipping students with the skills and attitudes necessary for meaningful cross-cultural interactions, making the learning experience transformative and impactful.

3.2. Chinese culture, Korean Hanbok, and intercultural communication competence

The Introduction to Chinese Culture course, a cornerstone of Chinese university curricula, aims to deepen students' understanding of the nation's rich history and cultural heritage. It covers material culture, spiritual traditions, and social institutions, emphasizing Confucian values such as social harmony, moral character, and respect for hierarchy. To enrich this understanding, the course includes a comparative exploration of Hanfu and Hanbok. Both reflect Confucian ideals, yet their designs and cultural contexts highlight how shared values take unique forms in different societies. Hanfu's flowing silhouettes and intricate embroidery emphasize grace and symbolism, while Hanbok's vibrant hues and structural simplicity convey modesty and practicality ^[7,8]. By studying these garments, students gain a deeper appreciation of how traditional attire embodies cultural identity and values.

This comparative study broadens students' global perspectives and fosters respect for cultural diversity. By examining historical connections, such as the influence of Tang and Song Dynasties on Hanbok, students

develop an understanding of the cultural exchanges between China and Korea. This not only strengthens their cultural identity and pride in their heritage but also enhances their intercultural communication skills.

In a globalized world, the ability to articulate cultural concepts is essential. The course bridges cultural understanding and language proficiency by teaching students to discuss Chinese culture—and its intersections with others—in English. Through this, students learn to explain how Hanfu and Hanbok represent Confucian ideals while highlighting their unique features. By integrating Confucian values, cultural education, and English language skills, the course fosters students' cultural awareness and confidence, preparing them to navigate and contribute meaningfully to a multicultural world while effectively representing Chinese culture.

4. Application of the UbD framework in the course design of Chinese clothing

Chinese clothing, with its rich and dynamic history, reflects the nation's cultural and social evolution. From the Zhou dynasty's garment regulations based on social strata to the fusion of Han and Manchu styles during later periods, Chinese clothing has continually adapted to societal changes ^[9]. For college students, understanding the historical development and cultural significance of traditional Chinese attire is essential, as it provides insights into China's material culture, spiritual values, and aesthetic traditions. By employing the UbD framework in teaching Chinese clothing, the course fosters not only cultural knowledge but also skills in global awareness, critical thinking, and intercultural communication.

Stage 1: Desired results

The desired outcomes focus on helping students connect traditional Chinese attire to broader cultural and historical contexts. Three key ideas are emphasized: (1) Historical and social evolution: Students explore how traditional attire reflects social hierarchy and Confucian values. (2) Symbolism and ethical values: The embedded meanings of colors, patterns, and materials in Chinese clothing are examined to understand their ethical and cultural significance. (3) Cultural awareness and respect for diversity: Students recognize how clothing shapes cultural identity and fosters respect for global cultural diversity.

Essential questions guide the inquiry process, encouraging students to reflect deeply. Examples include: How do traditional Chinese clothing styles reflect the values and social structures of their time? What are the similarities and differences between Chinese Hanfu and Korean Hanbok, and what cultural distinctions do they reveal?

Stage 2: Assessment evidence

Assessment strategies are designed to evaluate students' understanding of core concepts and intercultural communication competence. These include: (1) Class discussions: Students articulate insights into the evolution of Chinese clothing styles, such as Hanfu, Qipao, and Tang suits, and compare them with Korean Hanbok to explore design, symbolism, and cultural context. (2) Group discussions: Students engage with essential questions, analyzing how clothing serves as a marker of identity and heritage across cultures. (3) Comparative report: A written reflection on the differences between Hanfu and Hanbok demonstrates students' understanding of their historical and cultural significance and the intercultural connections between Chinese and Korean traditions.

Stage 3: Learning plan and activities

Teaching and learning activities are structured to guide students through the exploration of Chinese clothing history and cultural significance: (1) Interactive exploration: Students analyze images and descriptions of traditional Chinese attire, focusing on the symbolic meanings of colors, patterns, and design elements in

garments like Hanfu and Qipao. (2) Comparative analysis: The teacher presents images and videos of Hanfu and Hanbok, allowing students to explore their historical origins, design features, and cultural meanings. Students identify distinct and shared features, fostering critical thinking and intercultural awareness.

By integrating these stages, the course fosters intercultural communication competence, enabling students to understand and articulate the deeper cultural meanings of traditional Chinese clothing. Through comparative analysis of Hanfu and Hanbok, students not only deepen their understanding of Chinese culture but also cultivate an appreciation for the shared heritage and distinctions between neighboring cultures.

5. Conclusion

As society evolves, educators must adapt to create dynamic, engaging learning environments. The Introduction to Chinese Culture course, designed with the UbD framework, deepens students' understanding of Chinese history and philosophy while enhancing their intercultural competence. By integrating cognitive, psychomotor, and affective learning domains, the course fosters critical thinking and cultural appreciation. For instance, the Chinese Clothing unit explores the values reflected in Hanfu and its comparison with Hanbok, emphasizing both shared traditions and unique identities. This student-centered, inquiry-based approach equips learners with the skills to navigate cultural divides and serve as communicators of Chinese culture in a globalized world. Future research could apply the UbD framework to other cultural topics, incorporating real-world scenarios to further strengthen students' ability to convey cultural concepts effectively across contexts.

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Research on Monitoring and Intervention Systems for College Students' Mental Health Based on Artificial Intelligence

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Abstract: Due to the existing “island” state of psychological and behavioral data, there is no way for anyone to access students' psychological and behavioral histories. This limits the comprehensive understanding and effective intervention of college students' mental health status. Therefore, this article constructs an artificial intelligence-based psychological health and intervention system for college students. Firstly, this article obtains psychological health testing data of college students through online platforms or on-campus system design, distribution of questionnaires, feedback from close contacts of students, and internal campus resources. Then, the architecture of a mental health monitoring system is designed. Its overall architecture includes a data collection layer, a data processing layer, a decision tree algorithm layer, and an evaluation display layer. The system uses the C4.5 decision tree algorithm to calculate the information gain of the processed sample data, selects the attribute with the maximum value, and constructs a decision tree structure model to evaluate students' mental health. Finally, this article studies the evaluation of students' mental health status by combining multidimensional information such as the SCL-90 scale, self-assessment scale, and student behavior data. Experimental data shows that the system can effectively identify students' mental health problems and provide precise intervention measures based on their situation, with high accuracy and practicality.

Keywords: Artificial intelligence; Psychological health monitoring; College students; Dynamic monitoring; Decision tree algorithm

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1. Introduction

At present, many universities' mental health intervention systems are still in a relatively traditional stage, mainly relying on regular psychological assessments and face-to-face counseling. To address these issues, this study develops an artificial intelligence-based monitoring and intervention system for college students' mental health. The system integrates students' psychological assessment data, behavioral data, and intervention effects, and uses advanced decision tree algorithms to establish a dynamic and intelligent psychological health assessment

and intervention mechanism. Through continuous monitoring and personalized intervention of the system, students' mental health problems can be detected in a timely manner, and precise psychological support and intervention plans can be offered to guarantee that students receive appropriate assistance.

This article first introduces the importance and current status of mental health monitoring and intervention for college students and points out the limitations of traditional methods in personalized intervention and data integration. Subsequently, a mental health monitoring system and an intervention system based on artificial intelligence are developed, and data acquisition, system architecture design, and the application of the improved C4.5 decision tree algorithm in psychological assessment are elaborated in detail. Subsequently, the paper presents the results of data collection and analysis, focusing on how psychological assessment and behavioral data can be combined to provide decision support for personalized intervention. Finally, the application effect of the system is discussed based on the experimental data, and future research directions and improvement suggestions are proposed.

2. Literature review

In the field of mental health intervention and monitoring, multiple studies have explored different methods and effects, covering various aspects from robot coaches to the impact of financial anxiety on mental health. Jeong *et al.* proposed a robot coach that combines interactive positive psychological intervention and skill training to improve the mental health of college students ^[1]. Barkham *et al.* reviewed the process and effects of Routine Outcome Monitoring (ROM) and explored its application in psychotherapy ^[2]. Kapetanovic and Boson analyzed 477 sets of parental and adolescent data and found that parents overestimate the degree of parent-child communication, adolescent self-disclosure, and behavioral guidance, which is associated with externalization problems, internalization problems, and decreased happiness in girls, as well as increased externalization problems in boys ^[3]. Ravens-Sieberer *et al.* conducted a survey on the German COVID-19 Mental Health Study to track changes in the health quality of children and adolescents aged 7–17 years during the epidemic. They found that the epidemic significantly increased poor health quality and psychological problems, and led to an increase in anxiety and depression symptoms ^[4]. A study conducted by Liu *et al.* compared the effects of standard care, group psychological intervention, and pulmonary rehabilitation training on reducing anxiety and sleep disorders in mild COVID-19 patients in temporary hospitals ^[5]. Ryu and Fan explored the association between financial anxiety and psychological distress, as well as their moderating effects on gender, marriage, employment, education, and income levels ^[6]. Prudenzi *et al.* investigated the relationship between healthcare workers' happiness, occupational burnout, and safety practices, and analyzed the roles of mindfulness, values, and self-care ^[7]. The intervention effects of many studies are influenced by individual differences, social environment, and cultural background, leading to unclear universality and sustainability.

3. Methods

3.1. Original data center

Information was collected from three levels: registration data, psychological assessment data, and behavioral data, to establish an original database. At the same time, the collected data was processed in real time to lay the foundation for the subsequent construction of a mental health monitoring model.

- (1) Registration information: The platform first collected students' basic information such as student ID, name, gender, grade, major, as well as related data such as lifestyle habits, study pressure, and living

environment.

- (2) Psychological assessment data: By comprehensively analyzing psychological assessment tools such as SCL-90 (Symptom Checklist-90), SAS (Self-Rating Anxiety Scale), SDS (Self-Rating Depression Scale), and combining self-evaluation questionnaires, scenario simulation tests, etc., regularly or as needed, psychological health-related data such as emotional state, stress level, interpersonal relationships, and sleep quality of college students were collected.
- (3) Behavioral data collection: Collecting behavioral data such as frequency of use, browsing content, and interaction methods of students on the platform, and indirectly reflecting their psychological state through this information.

Through the multidimensional collection and processing of these data, solid data support has been provided for the construction of subsequent mental health monitoring models.

3.2. Psychological assessment based on improved decision tree algorithm

The psychological assessment system evaluates the mental health status of college students through four main levels: firstly, at the data collection level, the system summarizes students' registration information, psychological assessment, and behavioral data; next, in the data processing layer, these data are cleaned, integrated, and analyzed; then, at the decision tree algorithm layer, the improved decision tree algorithm is used to calculate information gain and select the best attributes, constructing a decision tree model; finally, in the psychological evaluation layer, the evaluation indicators are combined with the decision tree model to improve the accuracy of the evaluation results, and the evaluation results are presented in detail, as shown in **Figure 1** ^[8].

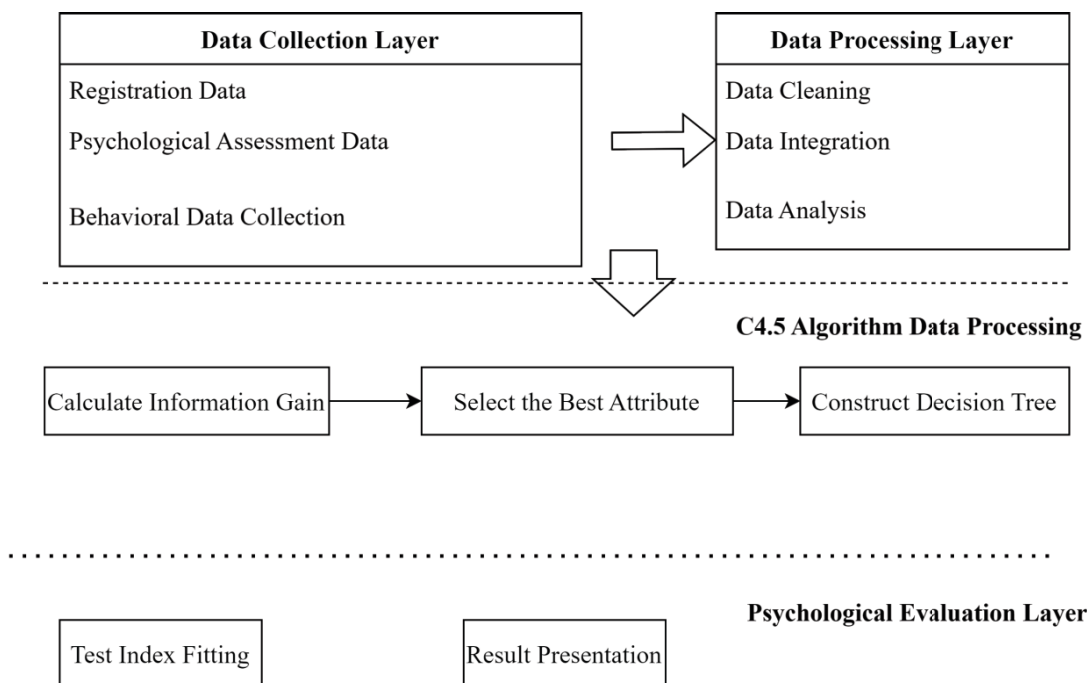


Figure 1. Overall architecture diagram of psychological assessment

In order to ensure the credibility of the measurement results, it is necessary to fit and calculate the characteristic factors of the evaluation indicators to improve the accuracy of the measurement results. Therefore, the decision tree algorithm has made the following adjustments:

$$\begin{cases} T = I(X) = \sum_{j=1}^m \frac{X_j}{X} \times I(X_j) \\ N = -P \sum_{j=1}^m I(X_j) \log_2^{I(X_j)} \times T \end{cases} \quad (1)$$

In the formula, T represents the constructed decision tree, $I(X)$ represents the parent node of the decision tree, $I(X_j)$ represents the child nodes of the decision tree, X_j represents the expected value of the child nodes, X represents the expected value of the parent node, m represents the number of decision tree nodes, and N represents the improved decision tree^[9,10].

4. Results and discussion

4.1. Data collection

Firstly, the SCL-90 self-assessment scale is the primary tool used to evaluate mental health. In addition, it also includes items related to diet and sleep, which are classified as the tenth factor—diet and sleep. Moreover, student behavior data is also an important component of analyzing mental health status. These behavioral data include students' frequency and duration of use on the platform, their participation in the mental health intervention module, and their performance in learning, attendance, and social activities.

4.2. Data analysis based on C4.5 algorithm

Figure 2 shows the scores of 10 students on different psychological health factors, and analyzes their psychological health status by combining classification labels. The visualization analysis of heat maps shows the differences in scores of different students on psychological health factors such as depression, anxiety, hostility, mental illness, and social sensitivity.

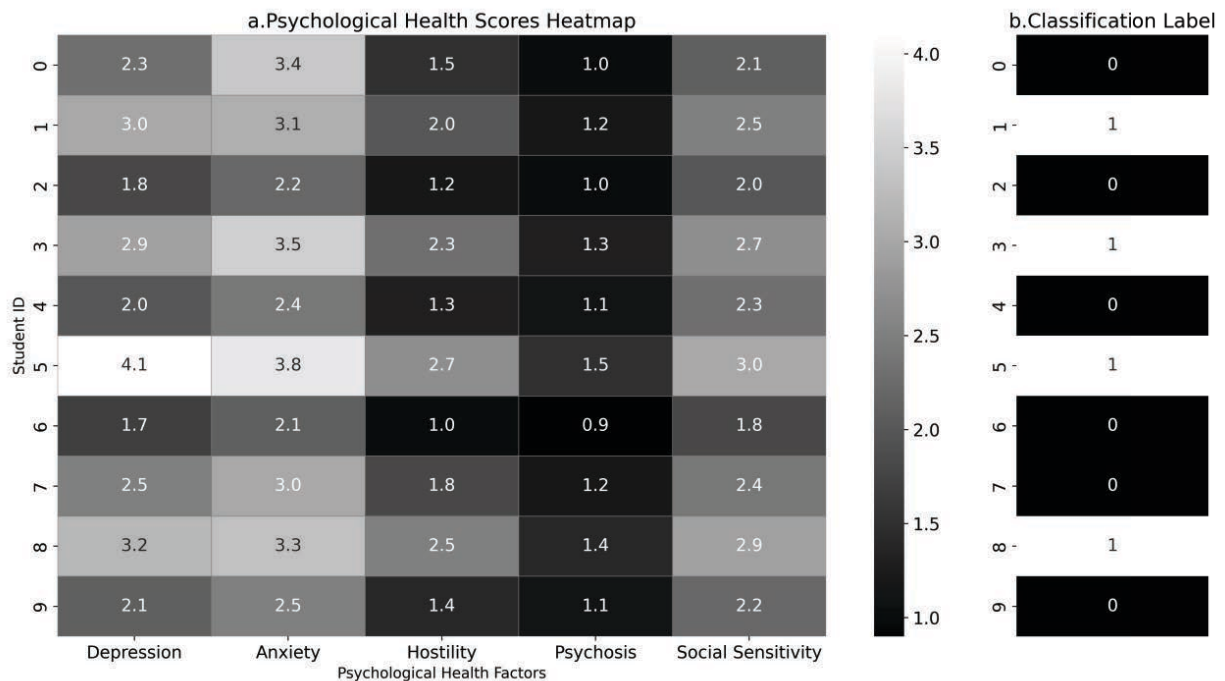


Figure 2. Psychological health score

Student 6 generally scores higher, especially in depression, anxiety, and social sensitivity, with scores of 4.1, 3.8, and 3.0, respectively, significantly higher than other students, which may be related to their classification as “abnormal” (as shown in **Figures 2a** and **2b**). Other students are marked as “abnormal,” such as students 2, 4, and 9, although their scores on various indicators are not always the highest, they show certain psychological health problems, reflecting the multidimensional nature of psychological health assessment. Overall, the data suggests that high scores for mental health factors, such as depression and anxiety, may be important indicators that affect students’ “abnormal” classification, and a comprehensive analysis of these factors can help further understand students’ mental health status.

According to the selected attributes, the data set is divided and the decision tree is recursively constructed. The results are illustrated in **Figure 3**.

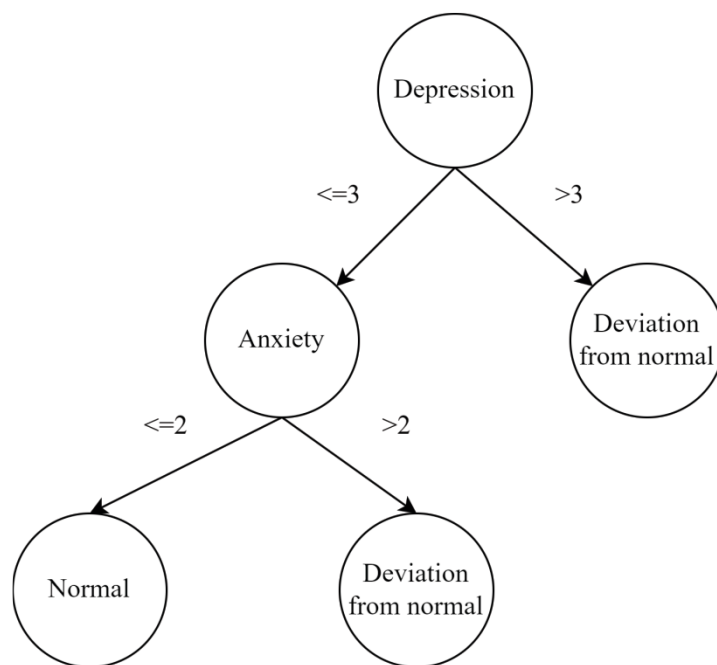


Figure 3. Structure diagram of decision tree

The discrimination criteria of this decision tree model are based on the scores of psychological assessment scales, such as the SAS and SDS. Through the scores of these scales, the decision tree can make a preliminary classification of the individual’s psychological state. The first branch node is “depression,” and if the threshold is greater than 3, it is classified as “deviating from normal.” If the threshold is less than or equal to 3, it enters the second node “anxiety.” If it is less than or equal to 2, it is judged as “normal.” Otherwise, the target is classified as “deviating from normal.” The process is shown in **Figure 3**.

For abnormal students (i.e. students predicted to be in the “Abnormal” category), the system provides personalized intervention plans based on individual circumstances. Specifically, the system recommends different types of intervention measures for these students, including group counseling, individual counseling, stress management courses, cognitive behavioral therapy (CBT), and relaxation skills courses. For example, student 2 is recommended to participate in group counseling, individual counseling, and stress management courses, while student 6 is recommended to participate in stress management courses and individual counseling. The specific data is shown in **Table 1**.

Table 1. Intervention results

Student ID	Prediction	Intervention suggested	Intervention status	Follow-up date
1	Normal	None	None	N/A
2	Abnormal	Group counseling, individual counseling, stress management course	Pending	2024/1/15
3	Normal	None	None	N/A
4	Abnormal	Individual counseling, cognitive behavioral therapy (CBT)	Scheduled	2024/1/10
5	Normal	None	None	N/A
6	Abnormal	Stress management course, individual counseling	Pending	2024/1/18

5. Conclusion

Many schools' psychological health warning and support systems are still in their infancy for a variety of reasons, making it challenging to promptly identify and address students' psychological issues. This study developed an artificial intelligence-based monitoring and intervention system for college students' mental health. By combining students' psychological assessment data, behavioral data, and intervention effects, the improved C4.5 decision tree algorithm was used for analysis and prediction, providing personalized mental health intervention plans for college students. The research results indicate that the assessment of mental health not only relies on traditional psychological measurement tools such as the SCL-90 scale, but can also be comprehensively evaluated through students' behavioral data such as academic performance, attendance, social activities, etc. This multidimensional data collection and analysis method provides more comprehensive and accurate monitoring of students' mental health status. Through the training of the decision tree algorithm, the system can effectively identify students with abnormal mental health status and automatically generate intervention plans based on the evaluation results, ensuring timely and personalized intervention measures. However, although this research system can provide precise intervention plans, factors such as individual differences, cultural backgrounds, and others may still affect the effectiveness of the intervention. Therefore, future research can further explore personalized intervention strategies for different groups.

Disclosure statement

The author declares no conflict of interest.

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Research on the Cultivation of College English Intercultural Communicative Competence under the Multimodal Interactive Teaching Mode

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Abstract: With the development of globalization, intercultural communicative competence has become one of the core qualities of modern college students. As an important platform to cultivate students' language skills and cultural literacy, the innovation of college English teaching mode is essential. Based on this, this paper mainly discusses methods to effectively cultivate students' intercultural communicative competence in college English teaching from the perspective of multimodal interactive teaching mode, hoping to provide references for improving the quality of college English teaching and students' comprehensive quality.

Keywords: Multimodal interactive teaching mode; College English; Intercultural communicative competence; Situational teaching

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1. Introduction

Language is the carrier of culture. Intercultural communication ability is not only the extension of language skills but also the key to understanding different cultures and effectively carrying out international communication. The traditional college English teaching mode often focuses on teaching language knowledge, ignoring the cultivation of students' intercultural communicative competence. Therefore, exploring new teaching modes, such as the multimodal interactive teaching mode, is of great significance in improving students' intercultural communicative competence.

2. Overview of multimodal interactive teaching mode

2.1. Multimodality and multimodal discourse

“Mode” in multimodal interactive teaching refers to the way in which human beings interact with the external environment through senses (such as vision, hearing, touch, etc.). Multimodal interaction involves the use of

multiple senses to interact. Multimodality is an indispensable part of human daily communication, which can make communication richer and more three-dimensional.

In terms of multimodal discourse, as the concrete embodiment of multimodal interaction, it mainly refers to the phenomenon of using hearing, vision, touch, and other senses, and communicating through language, image, sound, action, and other means and symbolic resources. In multimodal discourse, different symbolic resources can complement each other and jointly build a complete expression system^[1]. For example, in face-to-face communication, not only language will be used to convey information, but also nonverbal symbols such as facial expressions, body gestures, and so on can be used to strengthen or modify verbal expression. These nonverbal symbols and language symbols cooperate with each other to form multimodal speech.

2.2. Multimodal teaching mode

Based on the theory of multimodal discourse, multimodal teaching mode came into being. This teaching mode refers to the teaching mode that integrates two or more symbol system resources into a courseware for classroom teaching demonstration. It not only breaks through the limitations of traditional single-mode teaching (such as relying only on words or language), but also leverages modern scientific and technological means to integrate various symbol resources. Multimodal teaching mode is characterized by large amount of information, strong interest, and so on. Through the use of a variety of sensory stimuli and symbol resources, students can fully perceive the teaching content, so as to improve the learning effect.

3. Advantages of multimodal interactive teaching mode

3.1. Adapting to different learning styles

Multimodal teaching methods adapt to students with different learning styles with their unique flexible performance. In the traditional teaching mode, teachers often use a single teaching method, which is difficult to meet the learning preferences of all students^[2]. Multimodal teaching methods can provide rich learning resources for students with different learning styles by combining visual, auditory, kinesthetic, and other sensory channels. For visual learners, the multimodal teaching method provides a lot of visual information such as images and videos to help them better understand knowledge; for auditory learners, audio, lectures, and other auditory resources can become the main learning channels; for kinesthetic learners, practical operation and other kinesthetic activities can make students better use knowledge in practice.

3.2. Improving the quality of teaching

Multimodal teaching methods can effectively improve the quality of college English teaching and enhance students' learning effect. In the past, the teaching mode only involved students passively accepting knowledge, but the multimodal teaching method can stimulate students' interest in learning by introducing a variety of sensory channels^[3,4]. This teaching method can also provide teachers with more opportunities for teaching observation and feedback. Teachers can understand students' learning situation by observing their performances in different modes, so as to adjust teaching methods and strategies in time. This kind of instant teaching feedback can align teaching with students' needs and strengthen the teaching effect.

4. Current situation of cultivating college English intercultural communicative competence

In the current context of globalization, the cultivation of intercultural communicative competence has become one of the goals of college English education. With the increasingly frequent international exchanges, talents with intercultural communicative competence have shown great advantages in various fields. However, it should be noted that in the current college English teaching, the cultivation of college students' intercultural communicative competence still faces some challenges, which need to be analyzed in depth.

4.1. Separation of language teaching from cultural content

In college English teaching practice, some teachers solely focus on language skills training, ignoring the introduction of cultural content ^[5]. Language is not only a stack of words and grammar, but also a form of cultural expression. Each language contains rich cultural connotations. These cultural elements are an important basis for language understanding and application. However, in actual teaching, many teachers only pay attention to the teaching of language forms, such as language rules, vocabulary collocation, listening practice, and oral expression, without emphasizing the cultural background and context behind the language.

This teaching mode, which separates language teaching from cultural content, will lead to students' lack of necessary cultural sensitivity in cross-cultural communication. Although some students can speak grammatically correct sentences fluently, they cannot respond appropriately to each other. This cultural "blind spot" will not only affect students' communication effect but also easily lead to misunderstanding due to cultural differences ^[6]. Therefore, the integration of cultural content into language teaching can promote the cultivation of students' cultural awareness and intercultural communicative competence.

4.2. Lack of awareness of intercultural communicative competence training

In addition to the separation of language teaching from cultural content, some teachers and students still lack the awareness of cross-cultural communication. They even think that English learning is only for the purpose of coping with examinations and obtaining credits, lacking awareness of the important role of English as an international common language in cross-cultural communication. This utilitarian learning attitude will lead to students lacking interest in English learning and limit the development of students' intercultural communicative competence.

In addition, this lack of awareness leads to students' understanding of foreign cultures remaining limited to the content of textbooks, preventing the development of deeper cultural thinking ^[7]. For example, some students can recite foreign historical events, names, and cultural customs, but cannot really understand the meaning behind these cultural phenomena. This superficial cultural understanding is one-sided, which cannot help students flexibly use the knowledge they have learned in actual cross-cultural communication, nor can it cultivate their cross-cultural communication ability.

5. Application of multimodal interactive teaching mode in the cultivation of college English intercultural communicative competence

5.1. Enriching cultural materials with multimedia resources

In the cultivation of college English intercultural communicative competence, the use of multimedia resources plays an important role. Teachers should recognize the advantages of multimedia technology, make full use of the cultural materials in textbooks, and enrich the teaching content through multimedia means, so that students

can intuitively understand the customs of different cultural backgrounds. For example, with the help of the multimedia form of video, foreign life scenes, festival celebrations, customs, and habits are vividly presented in front of students. When students watch a foreign film or television play, teachers can guide students to pay attention to the language expression, non-verbal behavior (such as body language, facial expression), and cultural background elements (such as home decoration, clothing style, etc.) of the characters in the play, and simultaneously explain them. In this way, students can improve their language listening comprehension ability and cognitive understanding of different cultures^[8,9]. Audio resources are also an important part of multimedia teaching. Teachers can play music and radio programs from different countries, let students feel the rhythm of the English language and the way of thinking expression in different cultural backgrounds; teachers can share an international news audio and guide students to analyze the language characteristics and social values behind news reports, so as to cultivate students' cross-cultural critical thinking ability. The use of pictures can show the traditional costumes of different countries, guide students to explore the relationship between costumes and culture, and how costumes reflect the history of a nation.

Using multimedia resources to enrich cultural materials is one of the effective applications of multimodal interactive teaching mode in the cultivation of college English intercultural communicative competence. Through the comprehensive use of multimedia forms such as video, audio, and pictures, teachers can create a three-dimensional cultural learning environment for students, so that students can improve their understanding of different cultures in a relaxed and pleasant atmosphere and improve their intercultural communicative competence^[10,11]. For example, in an English class on "Chinese and Western festival culture," teachers can first show the celebration scenes of Chinese New Year and Western Christmas through videos, and let students compare and observe the differences in atmosphere, customs, and activities between the two festivals. Then an audio commentary on the origin of the festival is played to guide students to explore the cultural significance behind the festival. Finally, special pictures of the festival, such as Spring Festival couplets, Christmas trees, etc. can be shown while instructing students to make handicrafts related to the festival, so as to further deepen their understanding of Chinese and Western festival culture.

5.2. Designing cross-cultural situations to improve communicative competence

In the process of cultivating college English intercultural communicative competence, it is far from enough to rely only on the teaching of theoretical knowledge. In order to enable students to freely deal with problems in real intercultural communication scenes, teachers need to design a series of intercultural situations and let students learn communication methods in different cultures in practice through practical activities such as simulated dialogue or role play.

Teachers can design cross-cultural situations according to the teaching content to ensure that students understand the rules of communication in different cultures. In class, the teacher sets up a simulated dialogue scenario and then instructs students to have a simulated dialogue, so that students can play roles in different cultural backgrounds. For example, in the English class on Chinese and Western business etiquette, the teacher can require students to play Chinese businessmen and foreign customers so that students can experience the differences in business communication between China and the West through the simulated business negotiation process. During the simulated dialogue, teachers should pay attention to the differences in students' language expression, time concept, and other aspects, and give timely guidance^[12,13]. Teachers can also choose some scripts with cultural characteristics to let students perform in different roles. This is conducive to students' in-depth understanding of the communication methods of people in different cultures, and to exercise their

language expression ability in the performance.

5.3. Building a complete cultural multimodal database

In the cultivation of college English intercultural communicative competence, a perfect cultural multimodal database is an indispensable teaching resource. Schools should be fully aware of this, and actively establish and improve the database to support the development of cross-cultural teaching. This database needs to contain rich and diverse multimodal information. Building such a cultural multimodal database can not only provide students with rich and diverse learning resources, but also let students understand foreign history, art, and customs more vividly. Students can choose suitable learning materials according to their own interests and needs, so as to improve their learning initiative. At the same time, this database can also provide teachers with convenient teaching aids. Teachers can select appropriate materials from the database according to the teaching content and design diversified teaching activities, so that students can learn and experience cross-cultural communication knowledge in practice.

For example, when teaching the theme of “Indian culture,” teachers can select images and video data of traditional Indian costumes, Bollywood dance, and Ganges River sacrificial activities from the database, as well as text materials introducing Indian history and culture^[14,15]. In this way, teachers can design a series of teaching activities, such as watching videos and discussing the characteristics of Indian culture, writing essays on Indian festivals according to written materials, learning and trying to perform a Bollywood dance, etc. Such a multi-dimensional learning approach can help students deeply understand Indian culture and improve their intercultural communicative competence.

6. Conclusion

In conclusion, the multimodal interactive teaching mode provides a new idea for the cultivation of college English intercultural communicative competence. Through the rational use of multimedia resources, the design of intercultural situations, and the construction of a complete cultural multimodal database, students’ intercultural communicative competence can be effectively improved. With the continuous development of education, it is necessary to further explore the application of multimodal interactive teaching mode in college English teaching, so as to lay a solid foundation for students’ all-round development.

Disclosure statement

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Research on the Construction of “Same Course with Different Structures” Curriculum Resources Based on Knowledge Graphs

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Abstract: This paper explores the construction methods of “Same Course with Different Structures” curriculum resources based on knowledge graphs and their applications in the field of education. By reviewing the theoretical foundations of knowledge graph technology, the “Same Course with Different Structures” teaching model, and curriculum resource construction, and integrating existing literature, the paper analyzes the methods for constructing curriculum resources using knowledge graphs. The research finds that knowledge graphs can effectively integrate multi-source data, support personalized teaching and precision education, and provide both a scientific foundation and technical support for the development of curriculum resources within the “Same Course with Different Structures” framework.

Keywords: Knowledge graph; Same Course with Different Structures; Resource construction

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1. Introduction

With the development of information technology and the advancement of educational reforms, modern education increasingly emphasizes personalization and diversification. Traditional teaching models often adopt a “one-size-fits-all” approach, making it difficult to meet the personalized needs of different students. To solve this problem, the education community has proposed the “Same Course with Different Structures” teaching mode, that is, the same course content is designed differently according to the different needs and characteristics of students to achieve individualized teaching. “Same Course with Different Structures” emphasizes the diversified implementation of the same course content in different teaching environments to better adapt to individual differences among students and promote their personalized development. However, how to effectively construct and implement the “Same Course with Different Structures” curriculum resources has become an important topic in current educational research. In recent years, artificial intelligence technology has achieved breakthroughs, mainly reflected in machine learning represented by deep learning and knowledge engineering represented by knowledge graphs^[1]. As a

new artificial intelligence technology, knowledge graphs can enhance knowledge representation and bring new opportunities for personalized learning research^[2]. Knowledge graphs can intuitively present scattered knowledge points in a graphical manner and form a rich knowledge network through the association of nodes and edges. This technology has gradually attracted attention and been applied in the field of education, especially showing great potential in curriculum resource construction and teaching method innovation. By constructing knowledge graphs, multi-source data can be integrated and associated to form a structured knowledge system, thereby supporting personalized teaching and precision education.

2. Significance of constructing “Same Course with Different Structures” teaching resources based on knowledge graphs

Applying knowledge graph technology to empower education and teaching is considered the basic and prerequisite work for the digital transformation of education^[3]. In today’s digital age, the field of education is undergoing profound changes, and educational informatization has become a powerful driving force for promoting educational innovation and development. The construction of “Same Course with Different Structures” teaching resources based on knowledge graphs is an inevitable trend in this wave, and its importance and inevitability are increasingly prominent. With the rapid development of information technology, the ways of obtaining and disseminating knowledge have undergone fundamental changes. Traditional teaching resources often have the characteristics of fragmentation and isolation, making it difficult to meet the increasingly diverse and personalized needs of learners. As a powerful knowledge organization and management tool, knowledge graphs can effectively integrate and associate various teaching resources, providing a solid foundation for “Same Course with Different Structures.” “Same Course with Different Structures” itself emphasizes different teaching designs and implementation methods for the same course content by different teachers, aiming to stimulate teaching innovation and teachers’ professional growth. However, to maximize the value of “Same Course with Different Structures,” an efficient platform is needed to integrate and display these rich and diverse teaching ideas and practical results. Knowledge graphs, with their powerful semantic understanding and association capabilities, can clearly present the differences and commonalities among different teaching designs, helping teachers and learners to understand the diversity and flexibility of teaching more deeply. In addition, the development of educational informatization has driven education to pay more attention to student-centeredness, emphasizing personalized learning and independent exploration. The “Same Course with Different Structures” teaching resources based on knowledge graphs can push the most suitable teaching cases and learning paths for students according to their learning situations and interest preferences, truly achieving individualized teaching. Furthermore, from the perspective of sharing and dissemination of educational resources, knowledge graphs can break the limitations of region and time, enabling high-quality “Same Course with Different Structures” teaching resources to be shared and applied in a wider range, promoting educational equity and the overall improvement of educational quality.

In summary, the construction of “Same Course with Different Structures” teaching resources based on knowledge graphs is not only a positive response to the development of educational informatization but also an inevitable choice for improving educational quality and promoting educational innovation. It will bring new vitality and opportunities to the field of education and lead education toward a more intelligent, personalized, and efficient future.

3. Advantages of applying knowledge graphs to the development of “Same Course with Different Structures” teaching resources

In today’s field of education, it is an important mission for educators to continuously explore innovative teaching methods and resource construction models to improve teaching quality and effectiveness. “Same Course with Different Structures,” as an effective way to stimulate teachers’ teaching creativity and promote teaching exchanges and improvements, combined with knowledge graphs, a powerful tool, has opened up new paths for the construction of teaching resources. As a structured knowledge representation method, knowledge graphs can clearly show the associations and hierarchical structures among knowledge. Applying it to the construction of “Same Course with Different Structures” teaching resources has many significant advantages.

Firstly, it can comprehensively and systematically integrate the “Same Course with Different Structures” teaching resources of different teachers, covering teaching designs, teaching methods, teaching cases, teaching reflections, etc., and construct them into an organic whole, which greatly facilitates comprehensive comparison and in-depth analysis. Secondly, knowledge graphs can clearly present the internal connections among various knowledge points and the corresponding associations between teaching methods and knowledge points, which is of great benefit to teachers and students in deeply understanding the structure and internal logic of knowledge and can effectively improve the efficiency of teaching and learning. Thirdly, based on students’ learning characteristics and personalized needs, knowledge graphs can accurately recommend suitable “Same Course with Different Structures” resources and customize personalized learning paths to fully meet the differences in learning styles and learning progress requirements of different students.

At the same time, with the help of knowledge graphs, it is possible to intuitively compare the teaching methods and strategies of different teachers in the same course, facilitating teachers to learn from each other and absorb strengths, thereby optimizing their own teaching plans and vigorously promoting the innovation and improvement of teaching methods.

In addition, users can quickly retrieve the required specific teaching resources by relying on knowledge graphs and accurately locate specific knowledge points, teaching links, or teaching cases, thus saving time and energy. Knowledge graphs also facilitate the timely update and supplementation of new teaching contents, teaching methods, and related research results, ensuring that the “Same Course with Different Structures” resources always keep up with the times and continue to expand and enrich. It presents complex teaching resources and their interrelationships in a graphical and intuitive way, making the information clearer and helping teachers and students quickly grasp the overall structure and key points. More importantly, knowledge graphs provide teachers with a powerful tool for comprehensively examining the teaching process, helping teachers deeply reflect on the advantages and disadvantages of teaching and continuously improve teaching quality.

Finally, knowledge graphs are conducive to the long-term accumulation and proper preservation of high-quality “Same Course with Different Structures” teaching resources, promoting the sharing and inheritance of these resources among different regions and schools, and playing a positive role in promoting educational equity and the widespread popularization of high-quality educational resources.

4. Construction of “Same Course with Different Structures” teaching resources based on knowledge graphs

Firstly, knowledge graphs can systematically integrate various teaching elements in “Same Course with Different Structures.” The rich and diverse resources such as teaching designs, teaching methods, and teaching cases of different teachers for the same course can be organized and classified in an orderly manner through

knowledge graphs. This enables learners and educators to find, compare, and analyze different teaching ideas and strategies more conveniently, thereby deeply understanding the core points of the course and various teaching possibilities.

4.1. Integration and visual presentation of teaching resources

Firstly, knowledge graphs will classify and label the collected various teaching elements. This includes detailed classification of elements such as teaching designs, teaching methods, teaching cases, teaching questions, and classroom interactions of different teachers, and assigning specific labels for subsequent identification and association. Through semantic analysis technology, they extract the key information and core concepts in these teaching elements. For example, extract teaching objectives, key and difficult points from teaching designs; summarize the characteristics and applicable scenarios of different methods such as lecturing, discussion, and practice from teaching methods; utilize the association ability of knowledge graphs to establish connections among these teaching elements. For example, connecting specific teaching methods with corresponding teaching objectives and teaching effects can show the differences in the effects of different teaching methods in achieving specific teaching objectives. Furthermore, the graphical display method of knowledge graphs intuitively presents the hierarchical structures and logical relationships among various teaching elements, which clearly presents complex teaching elements in an easy-to-understand way, facilitating observation and analysis by educators and learners. In addition, knowledge graphs can also integrate teaching elements from different sources and in various formats. Whether it is a teaching design document in text form or a teaching record in video form, they can all be incorporated into a unified knowledge system. By continuously updating and improving knowledge graphs and incorporating new “Same Course with Different Structures” teaching cases and teaching elements, it can always maintain a comprehensive reflection and effective integration of teaching practice. Knowledge graphs, by means of their powerful classification, association, and visualization capabilities, can systematically and efficiently integrate various teaching elements in “Same Course with Different Structures” and provide powerful support for teaching research and practice.

Secondly, with the help of the visualization characteristics of knowledge graphs, the knowledge dissemination paths and the evolution processes of teaching methods in “Same Course with Different Structures” can be intuitively presented. Teachers can clearly see the differences in the effects of different teaching strategies in the process of knowledge transfer, so as to better reflect on and improve their own teaching methods. Students can also understand the course content from multiple perspectives, broaden their thinking horizons, and cultivate their innovation ability and critical thinking. The following are several ways to intuitively present the knowledge dissemination paths and teaching methods in “Same Course with Different Structures” with the help of the visualization characteristics of knowledge graphs: (1) Using nodes and connections: Different teaching elements (such as knowledge points, teaching links, teaching activities, etc.) are set as nodes and connections are used to represent the relationships and sequences among them. For example, starting from the node of the course introduction link, it clearly points to the nodes of the explanations of various knowledge points through connections, and then connects to the nodes of practice and consolidation, summary and induction, etc., forming a complete knowledge dissemination path. (2) Using colors and icons: Specific colors or icons are assigned to different teaching methods. For example, blue is used to represent the lecturing method, yellow represents the group discussion method, and green represents the practical operation method, etc. In this way, in the knowledge graph, the teaching methods used in different teaching links and their distributions and changes in the entire teaching process can be seen at a glance. (3) Displaying in layers:

The knowledge graph is divided into layers according to different stages of the teaching process, such as preview, new teaching, and review. Each layer shows the knowledge dissemination path and the teaching methods adopted in that stage, making the structural hierarchy of the entire teaching process clearly visible. (4) Marking key nodes and important links: Key knowledge points in knowledge dissemination or important steps in teaching methods are highlighted by thickening lines, enlarging nodes, adding special marks, etc. to attract attention. (5) Displaying knowledge points dynamically: Animation or interactive functions are used to simulate the knowledge dissemination process and the application sequence of teaching methods, allowing users to feel the progress and changes of teaching more vividly. (6) Adding annotations and explanations: Text annotations and explanations are added on the relevant nodes and connections of the knowledge graph to explain the functions, purposes, and associations of each teaching element with other elements, helping users better understand the teaching design ideas. Through the above multiple ways, knowledge graphs can comprehensively present the knowledge dissemination paths and teaching methods in “Same Course with Different Structures” in an intuitive, clear, and easy-to-understand visual form, providing powerful support and inspiration for teaching research and practice.

4.2. Construction methods of teaching resources

Constructing “Same Course with Different Structures” teaching resources based on knowledge graphs requires carrying out multiple steps in sequence. Firstly, clarifying the construction purpose, such as helping teachers improve teaching, students’ autonomous learning, or teaching research, and determine the disciplines, course contents, and teaching stages to be covered. Then, widely collecting relevant data, such as teaching designs, courseware, classroom records, reflections, and student feedback of different teachers, as well as textbooks, reference materials, and academic achievements. Then, it is necessary to clean and sort the data, remove duplicate, invalid, or incorrect information, and standardize and normalize it to unify the format and terms. Key knowledge elements such as knowledge points and teaching objectives are extracted from the preprocessed data and accurately defined and described. Based on the extracted elements, the model structure of the knowledge graph is constructed, determining the types of nodes and relationships. Associations among knowledge elements are established to form a network, such as connecting teaching methods with knowledge points and teaching objectives, and associating the teaching designs of different teachers with course contents. The knowledge from different data sources is integrated, eliminating conflicts and contradictions to ensure accuracy and completeness. Appropriate tools and technologies are used to transform the associated and integrated knowledge into a visual knowledge graph. Subsequently, quality assessment is conducted on the constructed graph, inviting experts, teachers, and students to try it out, give feedback, and check its accuracy, completeness, consistency, and usability. Finally, the knowledge graph is optimized and updated according to the assessment results and actual needs, continuously improving the teaching resources. Based on the above methods, a relatively complete and practical “Same Course with Different Structures” teaching resource based on knowledge graphs can be constructed.

4.3. Application mechanisms of teaching resources

To give full play to the role of “Same Course with Different Structures” teaching resources based on knowledge graphs, a series of application mechanisms need to be constructed. For example, the teacher training mechanism: carrying out training on the use methods of knowledge graphs and “Same Course with Different Structures” seminar activities to improve teachers’ understanding and application abilities of diversified teaching methods; the teaching design guidance mechanism can provide teachers with teaching design templates and examples based on knowledge graphs, and guide teachers to carry out innovative designs according to their own

characteristics and students' needs. A special teaching design consultation service is set up, and teachers can get help and suggestions at any time when encountering problems in the design process; for the teaching evaluation and feedback mechanism, a teaching evaluation index system based on knowledge graphs is established to comprehensively and objectively evaluate teachers' teaching effects. Students are encouraged to give feedback on the "Same Course with Different Structures" teaching, collect opinions, and feed them back to teachers in time so that they can improve teaching; the resource sharing and exchange mechanism is also important, an online platform is built to facilitate teachers to share the "Same Course with Different Structures" teaching experiences and resources based on knowledge graphs. Inter-school teaching resource exchange activities are organized to promote cooperation and common development among different schools; according to students' learning situations and characteristics, knowledge graphs are used to recommend suitable "Same Course with Different Structures" teaching resources for them to meet personalized learning needs; it is also important to regularly update the teaching resources in the knowledge graph to ensure that they keep pace with the latest developments in education and teaching. A special person responsible for maintaining the knowledge graph is assigned to ensure its normal operation and the accuracy of data.

5. Conclusion

In conclusion, future research should continue to deepen the exploration of the "Same Course with Different Structures" teaching mode based on knowledge graphs. Continuously optimizing and improving relevant technologies and methods can better serve educational teaching practice and promote the development of the education cause, and further apply the results to practice to promote the development and progress of the education cause.

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Educational and Teaching Reform Project of Beihua University: Research on the Construction of "Same Course with Different Structures" Course Resources Based on Knowledge Graphs

Disclosure statement

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Research on the Reform Path of College English Teaching in the Era of Artificial Intelligence

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Abstract: The development of a new round of artificial intelligence (AI) science and technology provided good technical support and condition guarantee for college English teaching, but it also brought new challenges. It is necessary and inevitable for English teaching to experience reform and innovation. China's AI digital teaching transformation is in the exploratory stage, and AI teaching mode has become the focus of future teaching development. Herein we propose a research method of integrating AI tools in college English teaching to adapt to the personalized learning of the new generation of college students, make the teaching process efficiently integrate the tide of the development of AI, promote the development of education evaluation system more accurately, and provide theoretical and data references for college English teaching reform.

Keywords: College English; Artificial intelligence; English teaching

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1. Introduction

Since the birth of artificial intelligence, it has quickly garnered people's attention. From factory sites to high-tech enterprises, from farmland to universities, from express delivery to sophisticated weapons, and from work to life, artificial intelligence seems to occupy every corner around us overnight. The wave of the globalization of artificial intelligence began in Western countries with developed science and technology and economic strength. English is a compulsory course for Chinese college students and is also the most frequently used language for communication in the world, so the impact on English teaching and education is more direct and intense. In general, the grammar and use of English are more in line with the original intention of artificial intelligence development. At present, Chinese university education has begun to attach importance to the development of artificial intelligence from various professional fields, and they want to leverage its initial and dividend period of development, open up the latest development strategy for the profession and direction, and become the leader of the industry. As an important part of university education in China, English teaching has obviously been deeply affected. From the organizational structure of basic courses and content, the teaching methods and communication channels of teachers and students, to the future layout of high-end talents, all need to adapt to the catalysis and promotion of artificial intelligence technology. Teachers, especially older teachers with

rich experience, need to learn the current information technology, actively use information tools and network platforms, and even take the initiative to create new artificial intelligence-related teaching methods and models, to contribute to students' learning in the new era, develop new ideas for university education, and provide new exploration and references ^[1]. It can be found that the reform path mainly includes the following aspects.

2. Human-machine cooperative intelligent teaching resources

The advent of artificial intelligence technology has enabled the creation and utilization of college English digital teaching resources, which are supplemented by traditional English teaching materials such as textbooks and reference books ^[2].

On the one hand, schools can develop more high-quality online English courses, such as inviting experts or excellent teachers in the field of English education to give video lectures to explain English learning to students and handouts, covering English key vocabulary, grammar analysis, explanation of example sentences, exercises, etc. On the other hand, teachers can use artificial intelligence technology to generate high-quality pictures and charts with rich interactive elements and combine them with English text, audio, and other teaching materials. Online libraries, MOOCs, TED Talks, and other platforms are used to build English course databases and embed them in mobile learning applications.

3. Data-driven intelligent learning and teaching processes

The essence of artificial intelligence is data-driven supported by multivariate data ^[3]. Data-driven human-machine collaborative preview not only helps English learners solve basic language problems encountered in pre-class preview, but also encourages English learners to think deeply, explore, and complete challenging and inspiring tasks. It stimulates English learners' reading breadth and depth to efficiently finish the pre-class preview. At the same time, artificial intelligence supports multi-dimensional comprehensive analysis based on college English teaching syllabus, teaching purpose, and teaching content, combined with the different data of learning characteristics such as knowledge background, cognitive level, learning expectation, and learning interest uploaded by each English learner. It then makes personalized preview plans according to learners' levels and pushes them to each learner in stages. Each learner can conduct personalized previews and optimize learning methods, improving learners' ability to think and explore knowledge and personal comprehensive literacy, and efficiently and quickly improve preview efficiency. Human-machine collaborative lesson preparation can continuously collect real-time data, stage data, and prediction data completed by learners for teachers, carry out accurate, objective, and large-scale multiple analyses, conduct comprehensive assessments of English learners with different abilities from different stages and degrees, and help teachers fully understand the preview situation of each learner ^[4]. According to the preview situation, massive information and teaching resources are collected to provide support for teachers' lessons.

According to the analysis results of artificial intelligence, teachers adjust and integrate teaching resources in combination with the content and difficulty of college English courses, design targeted teaching plans and overall teaching implementation strategies, match with the teaching design extracted by artificial intelligence, and complete the teaching preparation activities.

4. Human-machine cooperative intelligent teaching means and classroom teaching design

Artificial intelligence-based human-machine collaborative precision intelligent teaching realizes artificial

intelligence-enabled college English teaching ^[5]. Artificial intelligence updates and adjusts college English classroom teaching design in real time. It monitors and intervenes with English learners using real-time multi-modal technology such as image and voice recognition and expression picture processing, carries out accurate chemical situation analysis and management for each English learner, updates and adjusts the teaching plan and teaching design in real time, sets the next teaching path and predicts the teaching results, and improves the timeliness of classroom teaching ^[6]. Teaching activities are a complex process, but artificial intelligence is relatively rigid and has mechanical thinking, which lacks the integrity of teachers' thinking and cannot maintain a multidimensional close relationship with the surrounding environment. Therefore, human-computer cooperation is required to complete the teaching.

In the artificial intelligence-enabled human-machine collaborative classroom teaching of college English, teachers mainly focus on building a diversified teaching environment required by new classroom teaching, and decide whether the systematic correlation between various teaching elements is reasonable in combination with the learning situation data constantly fed back by artificial intelligence in the classroom teaching process. During collaborative teaching, different modes including personalized teaching modes and studying modes were designed to promote classroom teaching and organize teaching activities based on the analysis of learners' actual learning situation ^[7]. In classroom teaching, emphasis should be placed on overcoming major difficulties and error-prone points, and a large number of continuous language output practical activities should be designed; for example, in English teaching, teachers can introduce virtual teaching assistants based on artificial intelligence technology, which can simulate the behavior of human teachers, conduct personalized interaction with students, and help students improve their English application ability. It is possible to create and apply virtual English teaching tools by using network resources and new tools of artificial intelligence, combining with large databases of English language and speech, and superimposing local characteristics of different accents in various countries. It is released in the computer terminal and can directly communicate with students; through data collection, intelligent identification, and real-time feedback and error correction, teachers can understand and recognize students' spoken English, and assist students in completing oral English training and assessment, so as to complete the learning process of correct pronunciation for students ^[8]. Virtual teaching assistants can also assist English teachers in classroom management, such as automatically recording students' attendance, monitoring students' classroom performance and behavior, answering students' questions, publishing, collecting, and correcting students' English homework, etc., which can effectively reduce teachers' work burden and enable them to devote themselves to classroom teaching, thus improving the efficiency of English teaching. The use of artificial intelligence technology to build an intelligent recommendation learning system can conduct analyses of students' learning behavior, performance data, interests, and other information, thus teachers can use virtual teaching assistants to evaluate the quality of English teaching. For example, after the introduction of big data technology, virtual teaching assistants can collect learning data such as students' academic performance and classroom performance, generate learning reports, and conduct a comprehensive assessment of teachers' teaching process, so that teachers can have a comprehensive understanding of students' conditions, find weak links in teaching, and make scientific and reasonable teaching decisions.

5. Accurate evaluation system of human-machine collaborative personality

A personalized precision human-machine collaborative evaluation system, which combines artificial intelligence to strengthen the process evaluation of college English teaching with teachers' assessment of filling

learning attitude and emotion, forms a personalized precision evaluation system, so as to promote the long-term learning mechanism of college English learners. In the process of human-computer collaborative evaluation, artificial intelligence gives an objective and comprehensive assessment of the entire college English teaching process from both students and teachers, forming a tripartite data set of individual learner data, overall class learning data, and teacher teaching data, which are respectively evaluated by teachers and learners. It also forms a personalized comprehensive quality evaluation report of learners' learning process, providing more accurate learning data reference for teachers' next teaching and increasing the scientific nature of teachers' teaching decisions. Human-machine collaborative evaluation changes the singleness of traditional college English performance evaluation, forms a personalized and accurate evaluation system, and realizes a diversified and comprehensive evaluation of learners' data in all aspects.

6. Consideration and suggestions

In the English teaching process of artificial intelligence application, knowledge transfer and language skill improvement are the basis, and intelligent learning and communication mode and form are auxiliary. However, we should also see that teachers, computers, networks, and students are all indispensable links in the education and teaching environment. The essence of human-computer cooperative intelligent education in college English is human education, which should not only stay in the imparting and acquisition of knowledge, but also adhere to the principle of educating people, paying attention to the all-round development of learners' morality, intelligence, physical, aesthetic, and labor, and avoid educational alienation.

Secondly, artificial intelligence lacks teachers' emotional, social, and creative educational behaviors, which are irreplaceable in the humanistic care of education, and the dominant position of teachers in the process of education is also unshakable. While adhering to artificial intelligence-enabled education, college English human-computer collaborative intelligent education prevents technology from overtaking education.

Third, while artificial intelligence improves learning efficiency, it lacks inspiration. At present, the development of artificial intelligence is still in the initial stage, and intelligent assistance cannot fully match the high-energy and efficient all-round automation that people expect. As for the object of university education, college students should not completely rely on cold machines and data. Under the guidance of teachers, more attention should be given to cultivating the thinking ability and creative thinking of human beings, and strengthening learners' independent output practice and practice without the assistance of artificial intelligence, from human practice to machine practice and back to human practice. In this way, the improvement and transformation of the thinking and ability of the educated can be completed at a higher level, and the continuous progress of the application of intelligent technology can be driven, and a good cycle can be carried out on this basis.

Fourth, the more powerful function of artificial intelligence is to collect and integrate data and complete the induction of an extremely large amount of data under the control of humans, which is really the supreme weapon to improve the education evaluation system. Processing chips and software can extract thinking patterns and abilities from various data of teachers and students to evaluate different qualities of teaching and learning. It can improve the realistic evaluation system of man-machine collaborative education and clarify the specific connotation of intelligent elements in the evaluation process and its weight in the overall evaluation system.

7. Conclusion

Digital education is an important part of the construction of digital China and is also a critical platform to open up a new track for education development, shape new advantages in education development, and provide more

high-quality education. Information and intelligence are the only means and development trend of college English teaching. Instead of passively accepting it, it is better to take the initiative to change and catch up with the dividend period of intelligent English teaching in the early stage of development to embrace the era of intelligence, seize opportunities, respond to challenges, and enrich the connotation of talent training. The use of artificial intelligence in teaching resources and teaching methods is only the tip of the iceberg, and recognition and active integration are the connotation and driving force of college education informatization. In the near future, with active initiative and continuous optimization of the intelligence of education and teaching through practice, college English education can adapt to the development process of the information age and keep moving forward.

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Research on the Reform of Laboratory Teaching Management Models in Higher Education from the Perspective of Information Management

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Abstract: With the continuous advancement of information technology, traditional teaching management models can no longer meet the demands of modern laboratory management. Information management, characterized by efficiency, convenience, and intelligence, provides new ideas and directions for reforming laboratory teaching management models in higher education. Based on this, this paper explores reform strategies and practical approaches for laboratory teaching management models from the perspective of information management, aiming to offer references for enhancing the modernization and intelligitization of laboratory teaching management.

Keywords: Information management; University laboratories; Teaching management

Online publication: February 14, 2025

1. Introduction

The rapid development of information technology presents both challenges and opportunities for laboratory teaching management in higher education. Traditional management models face numerous shortcomings in terms of efficiency, resource utilization, and safety, necessitating innovation through information-based approaches. Information management can not only improve the efficiency of laboratory resource allocation but also enhance the standardization and scientific rigor of teaching management, providing strong momentum for the transformation and upgrading of laboratory teaching management models. Therefore, exploring laboratory teaching management reforms in higher education from the perspective of information management holds significant practical importance and value.

2. Building an information-based laboratory management platform

In the context of the information age, reforming the teaching and management model of university laboratories is imperative. Among these reforms, building an information-based laboratory management platform is of

utmost importance. Such a platform can not only enhance the efficiency of laboratory resource utilization but also standardize the experimental teaching process and ensure the quality of experimental education.

2.1. Platform function design

The design of the platform's functions must include an experimental reservation system as an indispensable component. Through this system, faculty and students can clearly view the real-time usage status of laboratories and schedule lab usage flexibly according to their teaching and research needs. This approach avoids potential resource conflicts and time wastage associated with traditional reservation methods, significantly improving laboratory utilization rates. Additionally, the reservation system can leverage historical usage records of faculty and students to intelligently recommend suitable laboratories and time slots, further enhancing the convenience and accuracy of scheduling.

With the implementation of a course management function, experimental teaching plans can be transparently and clearly presented to both teachers and students. Teachers can use the platform to publish experimental course information, including course names, teaching content, and required resources, while students can view and select courses via the platform. This process not only simplifies the cumbersome steps of traditional teaching but also ensures that experimental education is more organized and orderly^[1]. Furthermore, the course management function enables real-time tracking and evaluation of experimental courses, providing strong support for improving teaching quality.

The platform also facilitates a more scientific and rational allocation of laboratory resources. Based on real-time laboratory usage, equipment maintenance status, and the needs of faculty and students, the platform can automatically or semi-automatically allocate resources. This avoids resource idling and wastage while ensuring the smooth progress of experimental teaching. Additionally, the resource allocation function provides real-time monitoring and statistical analysis of resource usage, offering data support for optimizing resource allocation and scientific management.

2.2. Data integration and sharing

The information-based laboratory management platform enables real-time updates and sharing of laboratory resource information, allowing administrators, faculty, and students to access the latest status and usage conditions of resources at any time. This mechanism not only improves the efficiency of utilizing information resources but also promotes communication and collaboration between faculty and students^[2]. Furthermore, the data integration and sharing mechanism supports laboratory safety management. By analyzing and mining laboratory resource usage data, potential safety hazards and risk points can be identified in a timely manner, providing a scientific basis for enhancing laboratory safety management. During the development of the information-based laboratory management platform, emphasis must be placed on its stability and security. The platform should adopt advanced technical architectures and protective measures to ensure data integrity and security. It should also have good scalability and flexibility, incorporating cutting-edge laboratory management technologies to continuously update experimental knowledge for students. This ensures that the platform can better adapt to the evolving needs and demands of future laboratory teaching and management.

3. Optimizing experimental teaching processes

From the perspective of information management, optimizing the experimental teaching process is a key step to improving the efficiency and quality of laboratory teaching management in higher education. By integrating

online resources, applying intelligent monitoring technologies, and enhancing evaluation systems, the experimental teaching process can be comprehensively upgraded, thereby creating a more efficient, interactive, and personalized learning environment for students.

3.1. Experiment preparation and guidance

Traditional preparation methods often rely on printed textbooks, which contain large amounts of information that are difficult to navigate, making it hard to engage students' interest. However, in the context of information technology, abundant online resources provide new possibilities for experiment preparation ^[3]. By building a comprehensive online preparation resource library, students can access diverse preparatory materials such as experiment guides, instructional videos, and simulation experiments anytime and anywhere. These resources not only cover the basic theories and operational steps of experiments but also incorporate real-world cases and FAQs, helping students to deeply understand experimental principles and familiarize themselves with processes in advance. This establishes both theoretical and practical foundations for conducting various experimental activities in an orderly manner. Furthermore, online preparation platforms can provide intelligent guidance functions, recommending personalized learning paths and exercises based on students' progress and comprehension levels, thereby enhancing the effectiveness of preparation ^[4].

3.2. Experiment process monitoring

In university laboratories, monitoring the experimental process is crucial for ensuring the safety and quality of experimental teaching. Traditional monitoring primarily relies on teachers' on-site observation and recording, which can be subjective and incomplete, thus affecting the quality of monitoring. By leveraging intelligent monitoring technologies within information management platforms, real-time monitoring and data analysis of the experimental process can be achieved. For example, with sensors and cameras installed, the platform can collect key parameters such as temperature, pressure, and current during experiments, as well as students' operational behaviors ^[5]. After analysis, this data can generate experimental process reports, providing teachers with objective and accurate evaluation references. Additionally, intelligent monitoring technologies can detect and warn of potential safety hazards in a timely manner, ensuring the safe conduct of experimental teaching.

3.3. Experiment reporting and evaluation

Experiment reporting and evaluation are critical components of the experimental teaching process and essential for assessing student learning outcomes and the quality of experimental teaching. Traditional methods of report submission and evaluation often face challenges, such as the risk of losing paper reports and cumbersome assessment procedures. Information management platforms simplify this process significantly by offering online submission, automated grading, and feedback functionalities. Students can submit their experimental reports through the platform, which can automatically check the report's format and analyze its content, providing preliminary scores and feedback ^[6]. The feedback highlights students' strengths and shortcomings during the experimental process and offers targeted suggestions for improvement, helping them enhance their experimental skills and theoretical knowledge. Moreover, the platform enables online storage and sharing of experimental reports, allowing students and teachers to access and compare them conveniently, thereby supporting continuous improvement in experimental teaching quality.

4. Strengthening laboratory safety management

Laboratories, as critical venues for scientific research and teaching, require robust safety management. With the continuous advancement of technology and the expansion of laboratory facilities, traditional safety management methods are no longer sufficient to meet the needs of modern laboratories. Therefore, strengthening laboratory safety management by adopting advanced safety monitoring systems, safety training and drills, as well as risk assessment and early warning mechanisms, is essential for enhancing laboratory safety management standards.

4.1. Safety monitoring systems

By installing high-definition cameras, smoke detectors, temperature and humidity sensors, and other devices, real-time monitoring of the laboratory environment can be achieved. These devices can detect various abnormalities within the laboratory, such as smoke, fire sources, and temperature irregularities, and immediately trigger alarm systems. Safety monitoring systems can also upload monitoring data to the cloud in real-time, enabling management personnel to remotely view and analyze the data. This ensures that the laboratory's safety status is continuously monitored, allowing for rapid responses to emergencies and preventing the escalation of incidents ^[7]. However, having a safety monitoring system alone is insufficient. Laboratory safety management must also focus on enhancing the safety awareness and emergency response capabilities of faculty and students. To this end, universities should regularly conduct safety training and drills, utilizing virtual simulation technology for realistic training exercises. Virtual simulation technology can replicate actual laboratory environments and procedures, allowing faculty and students to practice experimental operations and safety drills in a virtual setting. Through such simulations, participants can familiarize themselves with various safety equipment and emergency protocols, improving their ability to handle unexpected incidents. This training approach not only offers a high degree of realism and interactivity but also effectively mitigates potential risks associated with real-world operations ^[8].

4.2. Risk assessment and early warning

In addition to safety monitoring and training, risk assessment and early warning are critical aspects of laboratory safety management. By effectively analyzing historical data, experimental operations, equipment status, and other relevant information, potential safety risks can be predicted, allowing for preventive measures to be taken in advance. Risk assessment and early warning systems enable real-time monitoring of various laboratory data. Upon detecting anomalies, they immediately issue warning signals to alert management personnel, faculty, and students to take appropriate actions ^[9]. This data-driven risk assessment and early warning mechanism facilitates precise identification and effective control of laboratory safety risks.

Building on this foundation, advanced data analysis technologies, such as machine learning and data mining, can be employed to deeply mine and intelligently analyze the collected data. These technologies can identify abnormal patterns and correlations within the data, thereby predicting risk factors that may lead to safety incidents. For example, analyzing the chemical properties and interaction rules of experimental materials can predict combinations that may cause explosions or release toxic gases. Simulating and optimizing experimental procedures can help identify and correct operational errors that might lead to accidents. Moreover, laboratory safety management should emphasize information sharing and collaboration. Establishing an integrated laboratory safety management information system can consolidate and share information from various safety processes, such as monitoring, training, and risk assessment. This integration ensures seamless data connectivity and efficient information flow. Such systems not only enhance the efficiency and accuracy

of safety management but also promote inter-departmental collaboration, fostering joint efforts to maintain laboratory safety and stability ^[10].

5. Conclusion

In summary, information management offers a new perspective and pathway for reforming laboratory teaching management models in higher education. With the support of information technology, laboratory resources are allocated more efficiently, management processes are optimized, and safety monitoring is strengthened, significantly improving the efficiency and scientific rigor of laboratory teaching management. As information technology continues to advance, it will play an increasingly vital role in laboratory teaching management in higher education, driving the modernization, intelligence, and efficiency of laboratory management. This progress provides a robust foundation for teaching and research in universities.

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The Reform Trends and Model Selection of University Scientific Research Organizations in the Post-College Era

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Abstract: In the post-college era, university research organizations are facing unprecedented changes in their structure and operational models. In terms of organizational form, these institutions are transitioning from single-discipline-based models to interdisciplinary and multidisciplinary collaboration models. This shift reflects the growing need to address complex, real-world problems that require expertise from multiple fields. From a management perspective, interdisciplinary research organizations face unique challenges. They must coordinate researchers from diverse disciplinary backgrounds, navigate potential conflicts between traditional departments and interdisciplinary units, and address differences in goals and organizational culture among members. These complexities make management more intricate and demanding. Simultaneously, the focus of university research organizations has become increasingly interest-driven, with research objectives, content, and participants reflecting specific areas of interest or societal demand. To adapt to these evolving trends, university research organizations must adopt flexible models tailored to their unique development needs. This approach will ensure the efficient execution of research activities and facilitate the effective transformation of research outcomes into practical applications.

Keywords: Post-college era; University scientific research organization; Interdisciplinary research

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1. Introduction

Since the introduction of the Humboldt model, universities have incorporated scientific research into their own responsibilities. The development of science continues to push forward human society. With the advent of the era of the knowledge economy, knowledge has been given a certain economic value. The university has also gradually moved from the edge of society to the center of society. In the post-college science era, the concept of “knowledge for knowledge” has been gradually replaced by the concept of “knowledge production with knowledge.” From college science to post-college science, the production mode of knowledge has undergone new changes, such as the diversification, application, and multi-subject of knowledge production demand.

Scientific research in the post-college era is not only pure scientific research hiding in the “ivory tower,” but also research that needs to go out of the sacred college hall for the development of the country and society.

2. Transformation of university research paradigm from college science to post-college science

The 17th century is the most critical century for the development of modern science. Initially, scientists explored knowledge for scientific research mainly based on “leisurely curiosity.” The research spirit of “knowledge for knowledge” supports their scientific research beliefs in this period. In the 1860s, the scientific mode of production has undergone significant changes. For example, scientific research pays more attention to social services and benefits. Scientific research institutions are no longer limited to universities, and scientific research management has become more complicated ^[1]. This revolution marks the emergence of post-college science. The emergence of college science also shows that the university’s scientific research paradigm is in transition.

2.1. Transformation of scientific research context from academic context to applied context

In the era of college science, university scientific research is mainly carried out in the academic context. The most primitive motivation for scientists to carry out scientific research is to enhance knowledge. In the era of science, the university’s knowledge production process mainly follows a single linear production model, that is, from basic research to applied research and then to development. After World War II, the rapid development of science and technology promoted the arrival of the era of the knowledge economy. In order to solve practical social problems, produce practical economic benefits, and serve the major strategic needs of the country, it is the main goal of scientific research activities in the post-college era. People are interested in science not only because it can stimulate intellectual interest but also because it can bring material benefits ^[2]. Therefore, in the post-college science era, university research is mainly carried out in the context of application.

2.2. Transformation of scientific research foundation from single discipline to interdisciplinary

Discipline is the result of knowledge accumulation to a certain extent in different professional fields. In the era of college science, scientists work mainly around a single discipline. There are strict academic boundaries between disciplines and the communication between disciplines is weak. Scientific research activities around a single discipline have their own academic norms, management reviews, and so on. There are isolated academic barriers between disciplines. Such a single discipline-based scientific research method can, to a certain extent, deepen the development of knowledge within the discipline. However, with the high degree of differentiation of disciplines, sub-disciplines have become more and more. Too refined single-disciplinary knowledge cannot be completed independently when solving complex social problems. At this time, it is necessary to carry out scientific research by forming an interdisciplinary research team. Therefore, in the post-college science era, university research and production are mainly carried out in an interdisciplinary context.

2.3. Transformation of scientific research review from peer review to multidimensional control

Due to the closed nature of knowledge in the scientific era of our college, the results of scientific research are mostly carried out in the form of peer internal review. The results of the review are generally to see whether the

research done by individuals has made outstanding contributions to the field of this discipline. The reviewers are experts in various disciplines and few outsiders are involved. After entering the post-college science era in the 1990s, globalization and informatization have led to increased competition among countries and have also had an impact on the development of research universities. The field of higher education is also involved in capital. On the one hand, research universities have set up many interdisciplinary research institutions based on their own development needs, and a variety of disciplines are interwoven in interdisciplinary research organizations, which makes the final evaluation not only in accordance with the evaluation criteria of one discipline. On the other hand, due to the limitation of funds and other factors, university scientific research cooperates with the government and enterprises, and its evaluation is bound to be reviewed by these investors. Therefore, in the post-college era, the main body of scientific research evaluation has increased, and the standards of scientific research evaluation have become broader. Scientific research review is changing from peer review to multidimensional control.

3. Transcending disciplinary boundaries: The changing trend of university scientific research organizations in the post-college era

Research organization refers to the organization that undertakes specific scientific research functions within the university. The main purpose of the research is to produce new knowledge to solve the needs of research topics^[3]. Under the condition of the change of research paradigm in the post-college era, the university scientific research organization with knowledge production and innovation as the primary task has also crossed the boundary of the discipline and is undergoing profound changes.

3.1. Diversified development of organizational forms

The earliest scientific research organizations in universities can be traced back to medieval universities. The medieval university mainly evolved from the spontaneous guild organization formed by one or more prestigious scholars and their followers in a certain field. These scholars' guilds generally focus on the interaction and exploration of knowledge centered on well-known scholars. However, they are not really scientific research organizations. Until the 17th century, with the proposal of the University of Berlin to unify teaching and scientific research, the scientific research organization of colleges and universities began to be institutionalized. In the era of college science, the way of university scientific research organization is mainly based on disciplines and departments. Typically, the tutor leads the students to carry out scientific research according to their own research topic, which is generally expressed in the form of a group or research team. The organization of scientific research is relatively simple. In the post-college science era, there are new changes in the organization of university scientific research. With the support of the "interdisciplinary" background, the organization of university scientific research is not confined to the research team around a single discipline but has changed in various forms. The most basic is the small-scale interdisciplinary team formed between the basic departments, institutes, or laboratories of the university. Secondly, there are school-level research institutes, research centers, and laboratories that cooperate with the government. In addition, research universities at home and abroad have begun to jointly establish collaborative innovation centers, high-tech industrial parks, or entrepreneurship centers with enterprises and scientific research institutes^[4].

3.2. Complexity challenges of organization management

In the post-college era, scientific research organizations in universities are mostly carried out in an

interdisciplinary way. These interdisciplinary organizations are different from previous scientific research organizations. The complexity of their research problems determines that they need researchers with different disciplinary backgrounds. The heterogeneity among members poses a greater challenge to organizational management. The first is how to balance the relationship between interdisciplinary research organizations and traditional departments. For example, the personnel working in interdisciplinary scientific research organizations generally implement the “dual employment system,” and it is inevitable that they will fall into a dilemma when managing such researchers. The second is how to coordinate and distribute the research objectives and interests of interdisciplinary organizations. The heterogeneity among members of interdisciplinary organizations will inevitably lead to differences in research objectives and the distribution of benefits.

3.3. Trend of organizational research interests

At the end of the 20th century, universities in Europe and the United States experienced the “second academic revolution.” Academic research and economic development were combined with industry and trade, and the economic development mission of universities was increasing ^[5]. Various research organizations working with third parties have been established in universities. These scientific research organizations cannot escape the orientation of interest from the beginning. The first is reflected in the interest of research objectives. The research goal determines the research direction of the whole scientific research organization. For instance, the “Manhattan Plan” with national interest-oriented research objectives, the school-enterprise laboratory with enterprise interest-oriented research objectives, and the scientific research organization created by research universities for their own interest development. Although these different types of scientific research organizations have varying research objectives, the final results will point to interest.

4. Organized research units: The model selection of university scientific research organizations in the post-college era

Interdisciplinary research has become the trend of the times when universities are required to change. The development of all interdisciplinary activities must have corresponding organizational carriers. Organized scientific research is a scientific research model that can efficiently integrate internal advantages and multidisciplinary resources to carry out task-oriented research ^[6]. Its essential attribute is a model of interdisciplinary organization. In today’s world, the developed countries led by the United States have already incorporated interdisciplinary research into the country’s major development plans, and the construction of organized research units has become more mature. At present, a new round of global scientific and technological revolution and industrial transformation is in the ascendant, disruptive technologies are constantly emerging, scientific and technological innovation is accelerating, and it is deeply integrated into and widely penetrated all aspects of human society, becoming the leading force to reshape the world pattern and create the future of mankind. If China wants to occupy a dominant position in international competition or if China’s universities want to obtain long-term development and occupy a place in world-class universities as soon as possible, it is necessary to choose a reasonable model based on its own situation. Organized research units conform to the trend of the reform of university research organizations in the post-college era and exhibit the following characteristics.

Clear task orientation: Exploring the development process of organized research units in the United States, it is not difficult to find that no matter what form of organized research units, such as laboratories in university escrow countries or independent research units in universities, they all have a common feature that they carry